This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

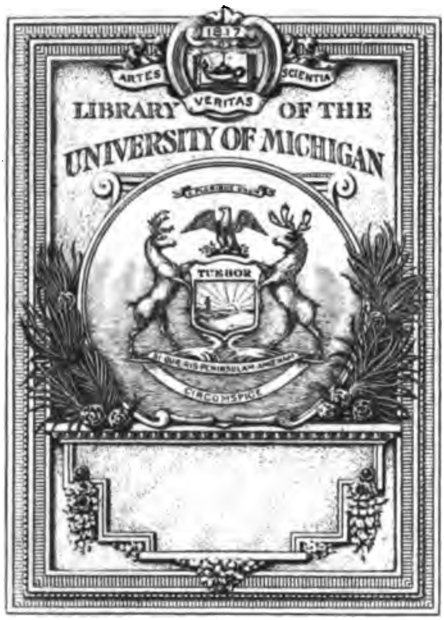
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at http://books.google.com/



Digitized by Google

AS
36
.A5
Copy

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA

FOR

PROMOTING USEFUL KNOWLEDGE

Vol. XV.

DECEMBER 1876.

No. 96.

PHILADELPHIA:
PRINTED FOR THE SOCIETY
BY M'CALLA & STAVELY.
1876.

Digitized by Google

Digitized by Google

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA

FOR

PROMOTING USEFUL KNOWLEDGE

Vol. XV.

DECEMBER 1876.

No. 96.

PHILADELPHIA:
PRINTED FOR THE SOCIETY
BY M'CALLA & STAVELY.
1876.

Digitized by Google

Digitized by Google

:.:' |
... ...
4-1: 17

THE
RHYNCHOPHORA
OF
AMERICA
NORTH OF MEXICO

BY JOHN L. LECONTE
ASSISTED BY
GEORGE H. HORN.

Digitized by Google

PROCEEDINGS OF THE AMERICAN PHILOSOPHICAL SOCIETY

Vol. XV. No. 96.

PHILADELPHIA
1876.

Digitized by Google

TABLE OF CONTENTS.

Digitized by Google

Digitized by Google

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY.

VOL. XV. DECEMBER, 1876. No. 96.

THE RHYNCHOPHORA OF AMERICA, NORTH OF MEXICO.

BY JOHN L. LECONTE, ASSISTED BY GEORGE H. HORN.*

PREFACE.

The task that I have attempted to perform in the present memoir, is a very difficult one, and I feel that it has been accomplished very imperfectly.

It is, namely, from the study of the very small material represented in the fauna of temperate North America, to induce entomologists to investigate those Coleoptera, which have been heretofore classed as *Curculionidæ* and some allied, but ill-defined families, from a completely new standpoint, whereby they become isolated from all other Coleoptera.

The characters which render necessary this isolation of the Rhynchophora have been already exposed by me in some short memoirs,† and their value has been recognized by several systematists of excellent ability, although not to the extent to which I hope the present effort will render them acceptable. These characters are mainly to be found in the form of the basi-lateral elements of the head and prothorax on the under surface of the body, and will be detailed in the Introduction.

By these peculiarities of structure, as well as by their food, the Rhynchophora are restricted to a more uniform type of organization than is exhibited in the normal Coleoptera; but at the same time being represented by an immense number of species, the generic modifications are very varied. The difficulty of tabulating these generic forms in a manner to exhibit their relations to each other is therefore greatly increased.

I have previously expressed my opinion that the Rhynchophora, being the lowest type of Coleoptera, are therefore geologically the oldest. Regarding then the fixity of insect types, as shown by the resemblance of ancient forms to those of the present time, the uniformity in food and manner

* See Proceedings, 1875, 649 (Nov. 19th); 662 (Dec. 17th).

† *Vide infra*, Introduction, p. ix.

Digitized by Google

of life, and the immense number of genera in this complex, with which we are dealing, we have a right to expect that there will be a proportionally larger survival of unchanged descendants of those species or genera which were first introduced. We will, therefore, have a more perfect series of connecting forms than can be found in other orders of insects, whose methods of life expose them to the influences of destruction or modification by external circumstances.

Nevertheless, the arrangement which I have adopted, will show in the larger groups or tribes, a dominance within the limits of each tribe of one typical modification of structure, with variations in the direction of modifications which become dominant, and definitive in other tribes.

It thus comes to pass that, neglecting the essential characters of the tribe, to which the species may properly belong, the definition of the genus will approximate in language very closely to that of some other genus, belonging to a very distinct part of the series.

In other words, the genera belonging to several tribes will agree with each other in similar characters of less value than the tribal characters.

What I have just said regarding genera is equally true in respect to species. The form, color and sculpture in many instances are repeated in tribes which from their geographical distribution and method of life cannot be supposed to have any immediate genetic derivation. Instances of this kind of resemblance will be mentioned both in the Introduction, and in the body of the memoir.

I have no theory to propound regarding this very complex system of cross resemblances. They are certainly not the result of mimicry, and probably not of natural selection, or any other name of an idea which has yet been suggested. A deeper insight into the phenomena of organic nature, which may, perhaps, be acquired by our successors would give us a more reasonable explanation of these resemblances.*

My best thanks are due to my excellent collaborator, Dr. G. H. Horn, for his careful study and classification of the family *Otiorhynchidæ*, certainly one of the most difficult among the Rhynchophora, and next to the genuine *Curculionidæ*, the largest. I also owe my kindest acknowledgment to Mr. G. W. Belfrage, for a large series of specimens from Texas; to Messrs. H. G. Hubbard and E. A. Schwarz, for very full series from Michigan and Florida; to the Museum of Comparative Zoology of Cambridge for the loan of the Zimmermann collection, mostly from the Southern States; and to Messrs. E. P. Austin, W. Jülich, and Prof. C. V. Riley for large sets of specimens from various parts of the country. Other friends have

* Mr. A. R. Wallace in his suggestive address to the Biological Section of the British Association for the Advancement of Science, held at Glasgow, 1876, has expressed himself quite clearly concerning the inadequate explanation of the resemblances between objects of diverse genera, tribes and families, which has thus far been offered. He comments at length on a certain relation between color and locality, not dependent on protective tendencies. This, however, is only one of several groups of curious facts which will be developed by more prolonged and minute observation. *Vide* Nature, Sept. 7th, 1876, p. 404.

Digitized by Google

also assisted me in proportion to the extent of their respective collections, and to them also I return thanks.

It is only justice to a master spirit in Zoology, who, with more imperfect knowledge of facts than we possess, was endowed with deeper intuition than is usually given to man, that I should conclude this preface with the following quotation from Oken's Physiophilosophy 3526.* What he discerned, I have endeavored to demonstrate.

"I have also declared the Rhynchophora to be the lowest and the Lamellicornes the uppermost in rank. A view, which at present appears to be generally adopted."

Philadelphia, December 23d, 1876.

* Elements of Physiophilosophy, by Lorenz Oken, M.D., from the German, by Alfred Tulk, London, Ray Society, 1847. The remainder of the section cited may be read with profit by all students disposed to accept words of advice from one who was well qualified to give instruction; but it is too long to be quoted on the present occasion, though teeming with thoughts suggestive of much that has since been adopted, without due reference to the original source.

Digitized by Google

Digitized by Google

INTRODUCTION.

Rhynchophorous Coleoptera are those in which the posterior lateral elements of the head* and prothorax† coalesce on the median line of the under surface of the body, so as to unite by a single suture.

To the first of these characters there is no exception in the wide range of the existing Coleopterous insects; to the second there are two notable discrepancies. The first is *Nematidium*,‡ commonly classed with the *Colydiidæ*, the other is the genus *Cossyphus*,§ which has been considered as belonging to the *Tenebrionidæ*, from the other members of which it differs, not only by the structure of the under surface of the prosternum, but by other characters, which require future study for a proper apprecia. tion of their importance.

I might rest the definition of the Rhynchophora at this point, and proceed to indicate the different series and families into which, according to the system I have developed, these insects should be divided, but before doing so, there appear to me certain relations between the members of this sub-order, which are well worthy of attention; and certain characters which I have not had time to investigate fully, but which are indicated for the guidance of those, who will in future adopt the views herein set forth.

There are also certain characters common to all, or nearly all Rhynchophora, most of which I have mentioned in the two essays cited below,‖ but which for convenience may be here briefly recapitulated:

1st. There are no soft, larval, or imperfectly chitinized forms, or forms with short elytra, exposed wings, or greatly multiplied antennal joints, such as are of frequent occurrence among the normal Coleoptera.

2d. There are none in which the side pieces of the prothorax are separated by suture from the pronotum, and very few in which even the lateral margin is indicated; in many the prosternal sutures are distinct, but in some even these are obliterated.

3d. In none are the front coxal cavities open posteriorly, though in some

* Le Conte, American Naturalist, Feb., 1875, ix, 112.

† Le Conte, American Journal of Science and Arts, July, 1867.

‡ This genus has been recently described by Reitter, Verhandl. naturforsch. Vereines in Brunn, 1876, as belonging to the *Trogositidæ*, under the name *Filumis*.

§ Horn, Tr. Am. Ent. Soc. 1868, p. x.

‖ Am. Journ. Sc. and Arts, July, 1867; American Naturalist, July, 1874.

Digitized by Google

the corneous plate formed by the coalescence of the posterior lateral elements (epimera) is very narrow; and in other cases (*Baris*, &c.) the posterior part of the prosternum is thickened and overlies the suture on the median line, but without coming into contact with the mesosternum.

4th. The ventral segments never exceed five in number, and the first and second are usually larger and more closely connected, frequently even connate, with partially obliterated suture; the fifth is sometimes longer than the fourth, sometimes about equal to it.

5th. When there is any appreciable difference between the sexes, it is usually manifested by a greater elongation of the beak of the ♀♀, indicating its use as an accessory organ of generation, for making the perforation in which the egg is subsequently placed by the soft ovipositor, and pushed down by the beak.

6th. The other sexual difference is in the addition of a small dorsal (or anal) segment to the ♂♂; this character is, however, not obvious in several families, the morphological representative of this anal segment being completely retracted and covered by the pygidium. In others this segment is visible only from beneath, simulating, therefore, a sixth ventral.

7th. The very rare occurrence of articulated movable spurs at the end of the tibiæ; it is seldom, indeed, that more than one fixed mucro occurs, and in the species in which the tarsi are inserted laterally near the tip, this mucro becomes frequently elongated and curved; the outer angle of the tip is in these instances quite often prolonged into a curved digitation, like the terminal tooth of the front tibiæ of some *Scaritini*, of the family *Carabidæ*.

8th. The head is most frequently prolonged in front of the eyes, forming a beak, which is usually narrower than the front, and frequently very slender. A flattened prolongation, similar to a beak, occurs in some genera of *Cucujidæ*, *Pythidæ* and *Œdemeridæ*, but not elsewhere in the normal Coleoptera.

9th. In the vast majority of species the labrum is wanting; in some *Scolytidæ* it is feebly developed, but is present in normal form only in *Rhinomaceridæ* and *Anthribidæ*.

10th. Except in *Rhinomaceridæ* and *Anthribidæ* the palpi are short and rigid, with the joints diminishing in size; in those families they are slender and flexible, as in normal Coleoptera.

11th. In those genera in which the hind tibiæ are truncate and margined at tip, forming a surface called a *corbel*, this surface may be glabrous or scaly. In normal Coleoptera they are always glabrous, and in *Hypocephalus* alone they are densely clothed with hair.*

12th. A peculiar ridge on the inner surface of the elytra, into which the ascending margin of the metathoracic epimera and ventral segments fit, giving great firmness and solidity to the hinder part of the body. This

* LeConte, Trans. Am. Ent. Soc. v, 200.

Digitized by Google

ridge is rarely wanting; and is represented among normal Coleoptera, so far as I have examined, only in certain *Buprestidæ*.

These characters taken collectively, in addition to the two fundamental defining characters first mentioned, indicate a profound difference in organization, which isolates the Rhynchophora from all other Coleoptera. From this isolation results the necessity of classifying them upon other characters than those which are found useful in defining series and families in the normal Coleoptera. The great resemblance in general appearance of the insects of this type, and the endeavor to consider them as only a family in the whole series of Coleoptera, has caused the characters used in this memoir to be either undervalued or overlooked. I believe, however, that when attention is directed to them, and to certain other characters, which I have not had time to fully investigate, the arrangement of these insects into natural groups will be found as simple and intelligible as that of the normal Coleoptera.

Among the investigations which yet remain imperfect, I would mention as specially deserving of attention, the stridulating organs. There are in some genera spaces on the inner surface of the elytra, which have a pearly lustre, and which are probably capable, by friction against the ascending margin of the ventral segments, of producing a sound. I have mentioned these under the genus *Listronotus*, of the *Phytonomini*, but they are present in many genera of other tribes, and in fact, the *Conotracheli* and many others are known to emit a squeaking sound.

The homologies of the parts of the head, by reason of which the front portion becomes extended into a beak, and the basal piece on the under surface (which separates the gular sutures in normal Coleoptera) disappears, are also worthy of attention; so too are the larvæ, with the view of discovering some general characters in which they differ from those of other Coleoptera.

A more careful study should also be made of the antennæ of the *Scolytidæ*, by specimens mounted in Canada balsam, so that the homologies of the joints of the funicle, when they disappear may be ascertained. The subject, as treated in this memoir, is, I may say, barely sketched, and will yield to others, who may devote labor to it, not only the correction of errors I have made, but many new truths and generalizations greater in value than those to which I have attained.

The affinities of the families of Rhynchophora among themselves, and their resemblances to various series or families of the normal Coleoptera remain to be indicated.

The typical Rhynchophora, *Curculionidæ*, while exhibiting in the different tribes characters which are more individualized and combined with special structures in the other families, occupy a central position around which the latter may be grouped.

The *Rhinomaceridæ*, by the presence of a labrum and flexible palpi, as well as by the general form of body, and 11-jointed, non geniculate antennæ, indicate a resemblance to *Rhinosimus*, &c., of the *Pythidæ*. The *Otiorhynchidæ*, in the tribes with large mentum, and the *Brachyceridæ* show

Digitized by Google

strong analogy with the higher *Tenebrionidæ*, in which the buccal cavity is entirely closed by the mentum.

By the gradual obsolescence of the deciduous mandibular appendage, and the scar, which is its natural consequent, the *Otiorhynchidæ* pass almost insensibly into the *Curculionidæ*. The last named family through the *Erirhinini* is affiliated with the *Rhynchitidæ*, and through the *Barini* with the *Calandridæ* and *Cossonidæ*.

The *Hylastes* group of the *Scolytidæ* shows strong affinities with the *Cossonidæ*, and a slight reversion towards the *Cryptorhynchini* of the *Curculionidæ*.

The *Brenthidæ* are isolated, and indicate a relationship which is neither of affinity or analogy, but rather of contemporaneous origin with *Hypocephalidæ*, *Rhysodidæ*, *Cupesidæ*, and perhaps some other families of normal Coleoptera, which have been yet imperfectly studied. Nevertheless, by certain abnormal genera, not occurring in our fauna, they exhibit a resemblance in some characters to the sub-family *Platypodidæ* of the *Scolytidæ*, and connect both, by their resemblances with the *Colydiidæ* of the Clavicorn series of normal Coleoptera.*

Some of the *Scolytidæ* in form and general appearance resemble the feebler groups (*Choragus*, &c.) of the *Anthribidæ*, but the characters of the latter are so peculiar, that they must be viewed as a synthetic type, combining resemblances to very diverse series. The form of the mentum, if I have interpreted it correctly, is found only in the Adephaga (*Amphizoa*), while the great sexual differences in the length of the antennæ occur only in the *Cerambycidæ*. The well developed labrum, filiform flexible palpi, straight, 11-jointed antennæ, and epipleuræ indicate a higher organization than is found in other Rhynchophora. The complete consolidation, without sutures, of the elements of the under surface of the head and prothorax, indicate a progress along the line of true Rhynchophorous development, upon which I have based the two fundamental defining characters. The progress in this instance has been carried so far as to cause the disappearance of these very characters. If any resemblance to the normal Coleoptera could be seen to replace them, the *Anthribidæ* would be removed, as has been done with the *Bruchidæ*, to some other part of the system. But this is not the case, and they must remain, therefore, as the expression of the most perfect development thus far attained in the Rhynchophorous type.†

The classification here adopted is simply that set forth by me in the memoir‡ above cited, which was read before the National Academy of

* It will be here remembered that *Nematidium* has the median suture behind the point of the prosternum precisely as in Rhynchophora.

† In this connection it is important to remark, that while the food of the Rhynchophora is almost universally vegetable tissues, either living or dead, *Brachytarsus* is a parasite upon a Hemipteron, of the genus *Coccus*, as narrated by *Nœrdlinger*, Stettin Ent. Zeitung, 1848, p. 230; Lacord., Gen. Col. vii, 481.

‡ American Naturalist, July, 1874.

Digitized by Google

Sciences, at the session held at Washington, April, 1874; I have, however, left out the families *Brachyceridæ*, *Amycteridæ* and *Belidæ*, defined in that essay, but which are not represented in our fauna.

There are three series, composed of eleven families, represented in Temperate and Arctic North America, which may be diagnosed as follows :

I. Abdomen ♂♀ alike ; pygidium small, elytra without lateral fold on inner surface.............................. **HAPLOGASTRA.**
  Labrum distinct, mandibles flat, simple.......... **Rhinomaceridæ.**
  Labrum wanting :
    Mandibles flat, toothed on outer and inner edge **Rhynchitidæ.**
    " stout, pincer-shaped................ **Attelabidæ.**

II. Abdomen ♂♀ dissimilar ; ♂ with an additional anal segment ; pygidium large ; elytra with acute lateral fold on inner surface....... .... **ALLOGASTRA.**
  A. Antennæ with annulated or solid club.
    Tarsi narrow, setose.
      Gular margin prominent, prosternum excavated................................. **Byrsopidæ.**
    Tarsi dilated, usually with a brush of hair beneath.
      Mandibles with deciduous tip, leaving a scar **Otiorhynchidæ.**
      Mandibles without scar, usually pincer-shaped............................... **Curculionidæ.**
  B. Antennæ with ten or eleven distinct joints..... **Brenthidæ.**

III. Abdomen ♂♀ alike ; elytra with a distinct lateral fold on the inner surface.................................. **HETEROGASTRA.**
  A. Pygidium vertical or declivous :
    Antennæ geniculate, clubbed ; labrum wanting ; last spiracle covered by ventral segments .... **Calandridæ.**
    Antennæ straight ; labrum distinct ; last spiracle not covered by ventral segments ; pygidium deeply notched to receive sutural apex of elytra........................... **Anthribidæ.**
  B. Pygidium horizontal, smaller :
    Antennæ geniculate, clubbed ; terminal edge of last ventral segment acute, surrounding the last dorsal ; tibiæ generally compressed and serrate......... .... **Scolytidæ.**
    Antennæ straight, with annulated club ; maxillæ very large, palpi and ligula feeble..... **Apionidæ.**

Among the genera and species described in the present memoir, there will doubtless be many which, with more extended comparisons, will be found identical with those which occur in other regions. It will be a just

Digitized by Google

criticism, that I have failed to identify them with those already in the books. In explanation of this, I would say that I have defined the tribes, genera and species, in many instances, by characters, which have been unnoticed or neglected by previous investigators; and finding that quite frequently, species, having a strong external resemblance, differed by structural characters of great moment, I did not feel warranted in applying to them names given to species, which agreed with them in the outline, vestiture and sculpture of the larger parts of the body, but which have been described from other zoological districts. It will be easy, by the aid of the structural characters which I have given, to identify my species with the types existing in European cabinets. I would rather that those I have named would sink into synonymy, than that, in the present condition of science, I should appear to teach false ideas regarding geographical distribution, which, when carefully studied, must give us important aid in attaining a knowledge of the causes and development of the existing order of things.

Digitized by Google

Family I. RHINOMACERIDÆ.

Mentum transverse, small, emarginate in front, supported on a very broad gular peduncle; ligula and palpi small.

Maxillæ exposed, lobes short, ciliate at tip, inner one very short; palpi 4-jointed, cylindrical, well developed. Mandibles flat, curved, acute, toothed on the inner side.

Antennæ inserted at the side of the beak near the end, 11-jointed, straight, first joint a little stouter than the second, but not longer, joints 2—6 nearly equal, 7 and 8 a little shorter and broader, 9—11 forming an elongate loose club, the last joint oval, pointed, divided transversely near the tip. All the joints are sparsely pilose, and those of the club are covered with sensitive surface.

Head prominent not deflexed, eyes convex, prominent, rounded, not very finely granulated; beak as long as the prothorax, rather flat, narrowest about the middle, wider at base and tip; without antennal grooves. Labrum distinct.

Prothorax truncate before and behind, sides convex, prosternal sutures distinct, widely separated, parallel in front, then curving inwards, and attaining the coxal cavity about the middle of its outer margin; coxal cavities rounded, confluent.

Mesosternum flat, pointed behind at the middle, coxal cavities rounded, confluent; trochantin large; epimera transverse, oblique, attaining the trochantin.

Metasternum rather long, side pieces narrow, slightly dilated externally in front.

Elytra covering the pygidium, rounded at tip, without epipleuræ, and without fold on the inner surface near the side.

Abdomen with five free ventral segments nearly equal in length, separated by straight sutures, intercoxal process acute; dorsal segments coriaceous, nearly equal in length, the last more corneous, articulating with the last ventral; anal segment of ♂ convex, not very prominent; side margin of abdomen acute, but not fitting into an elytral groove.

Anterior coxæ prominent, contiguous; middle coxæ rounded, contiguous; hind coxæ transverse, slightly separated by the acute intercoxal process, and extending to the side of the abdomen.

Legs slender, not elongated, tibiæ truncate at tip, middle and hind pair with small terminal spurs; tarsi brush-like beneath, 4-jointed, third joint broad deeply bilobed, claws divergent, simple or slightly broader at base (in our species).

This family contains a few species inhabiting the northern temperate zone, and depredating on the male flowers of coniferous trees; in which the eggs are deposited. As I have observed on a former occasion, this family is a synthetic or undifferentiated type in which the Rhynchophora make the nearest approach to the lower Heteromera; it is therefore inter-

Digitized by Google

esting to see that it clings to a very ancient and synthetic type of vegetation

Our species all belong to one genus.

RHINOMACER Fabr.

Pubescence long and coarse:
  Prothorax not longer than wide.................... 1. **pilosus.**
  Prothorax longer than wide........................ 2. **elongatus.**
Pubescence short and fine.......................... 3. **comptus.**

The ♂ differs from the ♀ by the front tibiæ being longer and slightly curved inwards, and the beak longer, more slender, and less dilated, at the tip. The tufts of hair at the middle of the third and fourth ventral segments of the ♀ are also present in our species.

The anal segment characteristic of the ♂ of the second series of Rhynchophora also exists in Rhinomacer, but is not prominent, and is almost concealed by the last dorsal segment, which is rounded at tip.

1. **R. pilosus,** n. sp.

Brown or blackish ; antennæ and legs paler ; pubescence long and coarse. Beak punctured and substriate, head densely punctured. Prothorax as wide as long, densely and strongly punctured, sides rounded. Elytra convex, parallel, elongate, coarsely punctured. Length 3.6 mm's ; .15 inch.

Lake Superior, Virginia, California ; four specimens.

2. **R. elongatus,** n. sp.

Blackish with a slight brassy tinge ; antennæ and legs brown ; pubescence pale brown, long and coarse. Beak with the outer half pale ; sculptured as in the preceding. Prothorax a little longer than wide, very densely punctured, sides very slightly rounded. Elytra rather narrower than in the preceding. Length 3.6 mm's, .15 inch.

Pennsylvania four specimens. Two are dark colored ; one dark with pale elytra, and one entirely pale brown.

One ♀ from Canada, with pale brown elytra has the form and sculpture of the other four, except that the prothorax is scarcely at all rounded on the sides, and is less densely punctured, and the elytra still more elongated. It may indicate another species, but I am unwilling to designate it as such without more specimens.

3. **R. comptus,** n. sp.

Form and size of *R. pilosus* ; blackish with a distinct brassy tint, clothed with short whitish hair. Head and beak as in the other species. Prothorax as wide as long, rounded on the sides, more finely and densely punctured. Elytra more densely and rugosely punctured. Stem of antennæ pale brown. Length 3.6 mm's ; 15 inch.

One ♀, Lake Tahoe, California ; Mr. Crotch. Quite distinct by the shorter pubescence and finer and denser punctuation.

Digitized by Google

Family II. RHYNCHITIDÆ.

Mentum small, subquadrate, supported upon a long narrow gular peduncle; ligula prominent, small, palpi short.

Maxillæ exposed, palpi short, rigid, as in Curculionidæ, 4-jointed.

Mandibles toothed on the outer and inner side; capable of great lateral extension; in repose the outer apical tooth on each projects forwards, so that two small acute teeth seem to project from the mouth.

Antennæ inserted at the sides of the beak, in position varying according to the genus; 11-jointed straight, first joint not elongated, and scarcely stouter, 2—8 slender, 9—11 broader, forming a loose club, and covered with sensitive surface.

Head prominent, not deflexed, eyes rounded finely granulated; beak slender, varying somewhat in form according to the genus.

Prothorax truncate before and behind, convex, prosternal sutures not visible, coxal cavities rounded, somewhat transverse, with a distinct fissure at the outer side margin: distant in Pterocolus, confluent in other genera.

Mesosternum flat, acute behind in all but Pterocolus, and with the side pieces normal in form and diagonally divided; in that genus they are transverse, prominent, apparently undivided, and ascend between the prothorax and humeral angle of the elytra, suddenly declivous and excavated in front for the protection of the legs; coxal cavities approximate, except in Pterocolus.

Metasternum rather long, with narrow side pieces; shorter with wide side pieces in Pterocolus.

Elytra separately rounded behind, exposing the pygidium in some genera; conjointly rounded, and covering the pygidium in others, epipleuræ distinct; submarginal fold on inner face short and straight.

Abdomen with five free ventral segments, nearly equal in length, separated by straight sutures, intercoxal process acute except in Pterocolus; ♂ without additional anal segment, pygidium in both sexes triangular, deflexed; sides of segments not forming an acute edge, and not fitting into a lateral groove of the elytra.

Anterior coxæ usually conical, contiguous, and prominent; smaller, rounded and separated in Pterocolus.

Middle coxæ similar to the front ones.

Hind coxæ transverse, reaching to the margin of the elytra, or nearly so.

Legs slender, rather long, tibiæ truncate at tip, with small terminal spurs; tarsi brush-like beneath, 4-jointed, third joint broad deeply bilobed; claws bifid, or acutely toothed.

Though nearly related to the preceding family, these species are readily distinguished by the absence of labrum, and the peculiar form of mandible, which recurs again only in *Desmoris*, an Erirhine genus of Curculionidæ.

While in Rhinomaceridæ a relationship to normal Coleoptera is seen in the presence of a labrum, and better development of maxillary palpi, a

Digitized by Google

similar tendency is evinced in the Rhynchitidæ by the distinct epipleuræ. In the anomalous genus Pterocolus moreover, the prothorax is distinctly and acutely margined at the sides, and excavated beneath, so as to form a large cavity for the reception of the front and middle legs. This character is seen in no other Rhynchophorous insect, and would almost warrant its reception as a distinct family. For the present however, I prefer placing it as a sub-family.

Sub-family I. RHYNCHITIDÆ.

The distinctive characters of this sub-family have been pointed out, but may be briefly resumed as follows:

Body rather elongate, or pyriform, front and middle coxæ contiguous, conical, prominent. Prothorax without side margin, not excavated beneath. Mesothorax with side pieces diagonally divided, epimera not ascending. Metathorax with narrow parallel side pieces.

Our genera are as follows:

Pygidium covered by elytra.
Elytra punctured irregularly.................. **AULETES.**
Elytra striate................................ **EUGNAMPTUS.**
Pygidium exposed, elytra with striæ of punctures, **RHYNCHITES.**

AULETES Sch.

Three species are known to me:

Antennæ inserted at the middle of the beak.
Black coarsely punctured, thinly pubescent............. 1. **ater.**
Antennæ inserted near the base of the beak.
Bluish black, densely punctured, thinly pubescent......2. **subcœruleus.**
Very small, brown, irregularly pubescent................3. **cassandræ.**

1. **A. ater,** n sp.

Robust, black, thinly clothed with very fine gray pubescence, which is easily rubbed off. Beak longer than the head and prothorax, nearly straight, slightly flattened above, coarsely punctured and slightly striate towards the base; head strongly punctured, eyes small, very convex. Prothorax as long as wide, slightly narrowed in front, very little rounded on the sides, strongly punctured, with a faint smooth dorsal line. Elytra twice as wide as the prothorax, very convex, deeply and coarsely punctured. Antennæ inserted about the middle of the beak. Length 3.6 mm's; .15 inch.

Illinois and Maryland; three specimens.

2. **A. subcoeruleus,** n. sp.

Less robust, blue black, thinly clothed with short suberect pubescence. Beak slender, as long as the head and prothorax, coarsely punctured, channeled towards the base; antennæ inserted near the base, head coarsely punctured, eyes larger less prominent. Prothorax a little wider than long, rounded on the sides, strongly punctured. Elytra one-half wider than the

Digitized by Google

prothorax, convex, less coarsely and more densely punctured. Length 3.3 mm's; .13 inch.

Nebraska; three specimens kindly given me by Mr. Ulke.

3. **A. cassandræ**, n. sp.

Very small, less robust, yellowish brown, varied sometimes with fuscous, irregularly clothed with rather coarse pale pubescence. Beak as long as the head and prothorax, coarsely punctured; head and eyes as in *A. subcoeruleus*; antennæ inserted near the base of the beak. Prothorax longer than wide, rounded on the sides, densely punctured, with a faint smooth dorsal line. Elytra one-half wider than the prothorax, coarsely punctured, punctures arranged in rows near the base. Length 2 mm's; .08 inch.

Detroit, Michigan, and Capron, Florida; collected by Messrs. H. G. Hubbard and E. A. Schwarz, on *Cassandra calyculata*.

EUGNAMPTUS Sch.

The species of this genus are more slender in form than the other members of the family, and the legs are longer and more feeble. According to the punctuation of the head, prothorax and elytra, the species may be readily recognized:

Elytral interspaces very narrow....................	1. **striatus.**
" " wider than the striæ.	
Front not channeled.	
Head feebly punctured, narrowed behind.	2. **angustatus.**
" " not " "	3. **collaris.**
" more strongly punctured, antennæ stouter..	4. **puncticeps.**
Front distinctly channeled..........................	5. **sulcifrons.**

1. **Eu. striatus**, n. sp.

Elongate, black, clothed with erect black hairs, head and prothorax reddish yellow. Beak black, coarsely punctured, distinctly carinate behind the antennæ, which are inserted about the middle and are long and slender; front sparsely punctured, obsoletely channeled. Prothorax longer than wide, sparsely coarsely punctured; dorsal line deep, abbreviated at each end. Elytra with striæ composed of deep transverse punctures closely placed; interspaces narrow, each with a row of distant but distinct punctures. Length 4.7 mm's; .19 inch.

Haulover, Florida; Messrs. Hubbard and Schwarz.

I have seen three ♀; the eyes are large, and the front rather broad and convex, as in the next species.

2. **Eu. angustatus** Gyll., Sch. Curc. v, 342; *Rhynchites ang.* Herbst, Käfer, vii, 140, Tab. 105, f. 4; *Anthribus nigripennis* Fabr., Syst. El. ii, 410; *Rhinosimus nigr.* Latr., Gen. Cr. et Ins. ii, 233; Hist. Nat. Cr. et Ins. xi, 27: *Rhynchites nigr.* Oliv., Ins. 81, 87, tab. 2, f. 39.

♂ eyes larger, front narrower, head gradually narrowed behind; middle tibiæ longer and slightly bent inwards near the tip; external apical tooth of mandibles not prominent.

Digitized by Google

♀ eyes less prominent, front wider, head broadly rounded behind the eyes and more convex; middle tibiæ straight; external apical tooth of mandibles very prominent.

Middle, Southern, and Western States to Texas. Very variable in color, but with the legs usually yellow, rarely varied with fuscous.

3. **Eu. collaris** Gyll., Sch. Curc. v, 341; *Anthribus coll.*, Fabr. Syst. El. ii, 410: *Rhynchites coll.*, Oliv. Ins. 81, 28, tab. 2, f. 40; *Rhinosimus coll.*, Latr. Hist. Nat. Cr. et Ins. xi, 27; *Rhynchites ruficollis* Germ., Ins. Nov. 188.

Middle, Southern, and Western States, to Texas. Equally variable in color, but the legs are almost always black, rarely varied with testaceous.

Of twelve specimens before me all seem to be ♀, and differ from those of the preceding species only by having the head behind the eyes cylindrical and not narrowed. It may possibly be a dimorphous form of *Eu. angustatus.*

4. **Eu. puncticeps,** n. sp.

Of the same form as *collaris*, testaceous clothed with erect hairs. Beak rather stouter less deeply sculptured, front obsoletely channeled, head coarsely and sparsely punctured, cylindrical not narrowed behind. Prothorax coarsely punctured, feebly channeled. Elytra with striæ composed of approximate punctures, interspaces wide flat, each with a row of very small distant punctures. Antennæ extending to the base of prothorax, stouter than in the other species. Length 3.6 mm's; .15 inch.

Illinois, Mr. B. D. Walsh; Georgia. I have seen but two ♀ of this species; it is easily recognized by the stouter antennæ, and more uniformly sculptured beak, which is free from the impressions and lines seen in the two preceding species.

5. **Eu. sulcifrons** Gyll., Sch. Curc. v, 343.

I refer to this species, a ♂ from Texas, sent by Mr. Belfrage. It is of exactly the same form and sculpture as *Eu. angustatus*, but the eyes are less prominent, more as in the ♀ of that species, and there is a fine but distinct frontal channel; the head is gradually and distinctly narrowed behind the eyes. The color is testaceous, with a lateral blackish vitta on the elytra gradually becoming broader behind; an extension of this dark color would give the appearance mentioned by Gyllenhal, in whose specimen the elytra were black with a blue reflexion, and pale piceous towards the base.

RHYNCHITES Herbst.

	Pubescent species...........................	2
	Glabrous species...........................	7
2.	Pubescence long erect........................	3
	" short, body red above.............	1. **bicolor.**
3.	Beak bistriate and carinate at base............	4
	" flattened not carinate at base............	6. **planifrons.**

Digitized by Google

4. Striæ distant not very distinct	5
" composed of large deep punctures.......	6
5. Color black bronzed..........................	2. **æneus.**
" blue..................................	3. **mexicanus.**
6. Beak narrow................................	4. **hirtus.**
" broad, dilated at tip....................	5. **glastinus.**

---

7. Legs dark colored............................	8
Legs yellow, body coppery golden............	7. **aureus.**
8. Bronzed, frontal fovea deep..................	8. **fossifrons.**
Frontal fovea obsolete........................	9
9. Blue bronzed, head strongly punctured........	9. **cyanellus.**
Coppery, head feebly punctured..............	10. **æratus.**

1. **R. bicolor** Herbst, Käfer, vii, 131, tab. 104, f. 6; Oliv., Ins. 81, 23, tab. 2, f. 31, Gyll., Sch. Curc. i, 212; *Attelabus bic.* Fabr., Ent. Syst. i, 2, 388; Syst. El. ii, 422; *Curculio bic.*, Fabr. locis variis.

An abundant species found on wild roses from the Atlantic to the Pacific coast. The head as far as the eyes, the prothorax and elytra are red in the specimens from the eastern part of the continent. I have indicated in my collection the following races:

α. Head entirely black. Oregon and California.

β. Head, stem of antennæ and legs red. Colorado.

γ. Red, except the club of the antennæ, and sides of metathorax, which are dark. Colorado.

The beak of the ♀ is shorter and stouter than in ♂, but I see no other sexual difference.

2. **R. æneus** Boh., Bull. Mosc. vi, 22; Sch. Curc. i, 215; Fahraeus Sch. Curc. v, 323.

Middle, Southern, and Western States to Colorado. A variety occurs, in which the elytra are testaceous. I observe no sexual differences in the specimens before me.

3. **R. mexicanus** Gyll., Sch. Curc. i, 227; Chevr., Col. Mex. 108.

I refer to this species one specimen from Arizona, very similar to *R. hirtus*, but of a blue color; the beak is rather shorter and broader, and slightly dilated at tip; the two striæ towards the base are equally apparent, and the front is similarly channeled. The head and prothorax are somewhat less coarsely punctured, and the elytral striæ are more evident, and composed of rather larger punctures. The differences, except in color and form of beak, are not obvious; the former may be variation, and the latter is, perhaps, sexual.

4. **R. hirtus** Oliv., Ent. 81, 26, tab. 2, f. 36; Gyll., Sch. Curc. i, 231, *Attelabus hirtus* Fabr., Syst. El. ii, 421.

Carolina to Florida.

5. **R. glastinus** Lec., Pacific R.R. Expl. and Surv., Insects, 52.

San Francisco, California. Remarkably different from our other species

Digitized by Google

by the broader, shorter, and more deeply sculptured beak. No sexual differences observed.

6. **R. planifrons** n. sp.

Moderately elongate, dark blue, clothed with long erect hair. Beak slender, as long as the head and prothorax, sparsely coarsely punctured, striate in front of the antennæ, flattened behind them, and margined at the sides. Head coarsely punctured, frontal channel short, deep. Prothorax slightly narrowed in front, not rounded on the sides, sparsely punctured, feebly channeled. Elytra one-half wider than the prothorax, impressed behind the base, striæ composed of very large distant punctures, interspaces rather wide, each with a row of small but deep punctures. Length 3.5 mm's ; .14 inch.

Cape San Lucas, Mr. Xántus. I have seen but one specimen. It is nearly of the same form as *R. mexicanus* but a little less robust.

7. **R. aureus,** n. sp.

Elongate, glabrous, bright coppery golden. Beak rather slender, punctured ; head coarsely and deeply punctured, with a narrow smooth frontal space which is channeled. Antennæ slender, testaceous with blackish club. Prothorax longer than wide, sides very slightly rounded, coarsely and deeply punctured. Elytra one-third wider than prothorax, impressed behind the base, striæ composed of deep close-set punctures, interspaces narrow, sparsely rugose. Legs bright testaceous yellow. Length 2.3 mm's; .09 inch.

Santa Barbara, California. Abundant, Mr. G. R. Crotch. The beak seems a little shorter and broader in some specimens, which are probably ♀ ; otherwise I perceive no sexual differences.

8. **R. fossifrons,** n. sp.

Elongate, glabrous, bronzed ; legs dark. Beak slender, as long as the head and prothorax, cylindrical, shining, sparsely punctured ; head coarsely but not densely punctured, with a deep elongate fovea on the front. Prothorax strongly punctured, not narrowed in front, very slightly rounded on the sides. Elytra one-third wider than the prothorax, impressed behind the base, striæ composed of deep approximate punctures, interspaces narrow, rugose. Length 2.3 mm's ; .09 inch.

One specimen, Mariposa ; Dr. A. Thevenet. Of the same form and size as the preceding, but differing by the beak, frontal fovea, more rugose elytra and dark legs.

9. **R. cyanellus,** n. sp.

Of the same form, size and sculpture as the two preceding, but of a dark blackish blue color. Beak slender somewhat flattened, strongly punctured ; head strongly and sparsely punctured, without frontal fovea. Prothorax and elytra as in *R. fossifrons*. Length 2.1 mm's ; .085 inch.

Massachusetts and Illinois ; four specimens. The subbasal impression of the elytra is less distinct than in the next species, and the general form more elongated.

Digitized by Google

10. **R. æratus** Say, Curc. 5; ed. Lec. i, 268. Gyll., Sch. Curc. i, 216.

Middle and Western States. Closely related to the preceding, but the color is coppery, and the head is finely granulated, and less deeply punctured; the beak is also longer and more slender. I have one specimen of a dark blue color, resembling *R. cyanellus*, but with the head faintly punctured.

Sub-family II. PTEROCOLIDÆ.

A single species constitutes this sub-family. On account of the anomalous characters its place in the series of Rhynchophora has been changed from time to time, without very satisfactory results. The latest authority, Lacordaire, deceived by the broad form of body, and ascending side pieces of the mesothorax placed it in the neighborhood of Ceutorhynchus. A study of the mouth organs, as well as the antennæ, shows that it is allied to Auletes and Rhynchites, while the other differences require it to be received as a very peculiar and distinct type.

It differs from the genuine Rhynchitidæ by the antennæ inserted much nearer the eyes, which are suddenly but not deeply emarginate in front. The side margin of the prothorax is acute and well defined, and the under surface, with the anterior part of the mesothorax, is excavated, forming a large cavity for the reception of the front and middle legs. The elytra are sculptured with wide shallow grooves, which are confusedly punctured; the epipleuræ are distinct; the tips are widely dehiscent and separately rounded, exposing parts of three dorsal segments, all corneous and densely punctured. Front and middle coxæ small, rounded, widely separated, not prominent; posterior coxæ separated, transverse, intercoxal process broad. Tibiæ with two distinct apical spurs, tarsi dilated, claws appendiculate. Ventral segments short; pygidium less convex in the ♂, and strongly inflexed. Side pieces of mesosternum transverse, solid, ascending between the prothorax and elytra. Side pieces of metasternum wide.

PTEROCOLUS Sch.

1. **P. ovatus** Gyll., Sch. Curc. i, 240; Labram & Imhoff, Curc. 70; *Attelabus ovatus* Fabr., Syst. El. ii, 426; Oliv. Ent. 81, 11, tab. 1, f. 13; *Apotomus ovatus* Kirby, Fauna Bor. Am. iv, 205.

Michigan and Massachusetts to Florida. Easily known by its robust form and beautiful blue color.

Family III. ATTELABIDÆ.

Mentum very transverse, short, trilobed, supported on a very large quadrate gular peduncle; ligula and palpi small.

Maxillæ exposed, lobes small, palpi rigid, 4-jointed.

Mandibles flat, pincer-shaped, rather stout, toothed on the inner side.

Antennæ inserted rather on the upper surface than at the sides, straight, 11-jointed; first and second joints stouter, 9—11 larger forming a loose elongate club covered with sensitive surface.

Digitized by Google

Head prominent, not deflexed, eyes oval, finely granulated, not prominent; beak short and stout, thicker at the end beyond the insertion of the antennæ; antennal grooves short and broad.

Prothorax truncate before and behind, convex; prosternal sutures not distinct, coxal cavities confluent, rounded.

Mesosternum flat, declivous, triangular, pointed behind; side pieces short transverse, diagonally divided, epimera not attaining the coxæ.

Metasternum short, side pieces wide.

Elytra not covering the pygidium, separately rounded at tip; epipleuræ narrow but distinct; inner surface without lateral fold.

Abdomen with five short ventral segments separated by deeply impressed straight sutures, intercoxal process acute; fifth at the middle very short, being compressed by the inflexion of the pygidium; side margin not acute nor extended upwards. Dorsal segments convex, almost corneous. Pygidium small corneous, upper margin with a large deep marginal groove.

Anterior coxæ conical, prominent, contiguous; middle coxæ somewhat transverse, and a little prominent; hind coxæ transverse, nearly contiguous.

Legs stout, tibiæ serrate on the inner side, armed at the tip with two strong hooks, which represent the spurs in the two preceding families; tarsi dilated, brush-like beneath; third joint deeply bilobed; claws connate at base.

A family containing but few genera, with less than 200 species, distributed mostly in the tropics.

ATTELABUS Linn.

The species of this genus which occur in our fauna, are divided by Mr. Jekel (Ins. Saundersiana ii, 186), into three groups:

I. Glabrous; front thighs less thick, not toothed: HOMÆOLABUS.
Blue black; prothorax, neck, elytra and abdomen red... 1. **analis.**

II. Glabrous, front femora thick, strongly toothed (in ♂): SYNOLABUS.
Red; legs usually black or dark.......... .... 2. **nigripes.**
Black, elytra partly red.
Apical angles of beak not prominent.................3. **bipustulatus.**
" " acute, " .... 4. **genalis.**

III. Pubescent, front femora not toothed, HIMATOLABUS. 5. **rhois.**

1. **A. analis** Illiger., Schneider's Mag. v, 616; Gyll., Sch. Curc. i, 199; Harris, Ins. Inj. Veg. 58; *A. similis* Kirby, Fauna Bor. Am. iv, 204.

♂. Ventral segments with two rows of acute tubercles; under surface of mouth flat.

♀. Ventral segments not tuberculate; under surface of mouth with two small acute teeth projecting downwards.

Abundant in the Atlantic States. With a large series of specimens before me, I cannot agree with Mr. Jekel, in separating *A. similis* as distinct on account of the darker color, and less lustrous elytra.

Digitized by Google

I have one specimen from New York in which the prothorax is very distinctly punctured, but it does not otherwise differ.

2. **A. nigripes** Lec., Ann. Lyc. Nat. Hist. (N. Y.), i, 171; pl. 11, f. 6; Gyll., Sch. Curc. i, 199.

♀. Front thighs unarmed.

♂. Front thighs strongly toothed.

Atlantic States to Kansas; abundant. The legs are usually black or dark brown; in one specimen from Texas (Belfrage), they are of the same red color as the body. In other specimens the head prothorax and part of the under surface are dark brown.

3. **A. bipustulatus** Fabr., Mant. 229; Syst. El. ii, 418; Gyll. Sch. Curc. i, 201; Harris, Ins. Inj. Veg. 58.

Atlantic States, not rare. The front thighs are armed with a small acute tooth in all the specimens I have seen.

4. **A. genalis**, n. sp.

Of the same form and size as *A. bipustulatus*, but with the apical angles of the beak acute, and projecting laterally. The color is black, not blue, the elytra are red with a large triangular scutellar spot, and a large apical blotch black; the abdomen is red. Length 3.2 mm's; .125 inch.

♂. Front thighs armed with a long slender tooth.

♀. Front thighs unarmed.

New Mexico. The species in our fauna resemble each other in form and sculpture to such an extent, that I have not thought necessary to give a more detailed description of this very distinct species.

5. **A. rhois** Boh., Bull. Mosc. vi, 21; Gyll., Sch. Curc. i, 202; *A. pubescens* Say, J. Ac. Nat. Sc. Phil. v, 252; ed. Lec. ii, 315.

Lake Superior to Virginia. Not rare on hazel bushes.

Attelabus scutellaris Say does not belong to this family, and is the type of the genus *Piazorhinus* Sch.

Family IV. BYRSOPIDÆ.

Mentum moderate in size, trapezoidal, wider in front, concave in our species; gular peduncle very small; ligula and palpi small.

Maxillæ exposed, small, palpi very short.

Mandibles stout and short, pincer shaped, without apical scar.

Antennæ short, inserted in front of the eyes, sub-geniculate; scape short, funiculus 7-jointed, the last joint wider forming part of the club in *Thecesternus*, club annulated, oval, pointed, and covered with sensitive surface.

Head strongly deflexed, beak short, stout, not emarginate at tip, separated from the head beneath by a strong gular constriction, for the reception of the antennæ. Eyes transverse narrowed beneath.

Prothorax rounded in front, deeply excavated beneath for the reception of the head and beak, coxal cavities small, confluent; prosternum visible in *Thecesternus*, as a triangular plate in front of the coxæ.

Digitized by Google

Meso- and metasternum very short, side pieces of the latter not separate.

Elytra connate, covering the pygidium.

Abdomen with the first and second ventral segments very large, connate. the suture effaced at the middle; third and fourth short, fifth as long as third and fourth united; sutures straight, very deeply impressed; intercoxal process broad. Anal segment of ♂ small, rounded at tip.

Anterior coxæ small, contiguous, rounded somewhat prominent; middle coxæ separated, small, rounded; hind coxæ small, oval, widely separated, distant from the side of the elytra.

Legs slender; tibiæ sinuate on inner side, truncate at tip, and armed on the inner side with two small terminal anchylosed spurs. Tarsi 4-jointed, narrow, joints cylindrical, setose or spinose beneath. Third joint not at all dilated or bilobed in *Thecesternus*. Claws slender, simple, separate.

This family contains but a small number of genera, all confined to the Eastern continent, except *Thecesternus* which is restricted to the interior parts of the United States, extending into Texas and eastward to Illinois. It forms a tribe distinguished from other Byrsopidæ by the peculiar conformation of the prosternum, which forms a triangular plate in front of the coxæ.

THECESTERNUS Say.

I have described (Proc. Acad. Nat. Sc., 1856, 18) what I at that time believed to be six species of this genus, in addition to the one described by Say. Subsequent investigation with more abundant material has raised some doubt in my mind as to the validity of the specific differences which I then observed.

It is quite evident that there are several species, but it is found quite impossible to define them. There are all gradations from specimens (*T. humeralis*) in which the humeral processes are fully one-third as long as the prothorax, to others (*T. morbillosus*) in which the elytra are truncate at base, and the humeral angles only slightly prolonged.

It may be regarded therefore as a genus in which the originally distinct species are becoming effaced by mixture.

The specimens which I collected in Kansas were found under dried buffalo-dung. I have since received several individuals from Illinois, Texas, and Missouri; upon one of the latter is this note, made by Mr. C. V. Riley: "Cutting off blossoms of grapevines in May; also beaten from *Carya*."

Well preserved and clean specimens are mottled with a pale ochreous crust composed of closely adhering minute scales. The bibliography is as follows:

1. **T. humeralis** Say, Curc. 8; ed. Lec. 1 267; Lacord., Gen. Col. pl. 67, f, 8; *Brachycerus humer.* Say, J. Ac. Nat. Sc. Phil. v, 254; ed. Lec. ii. 316; *Lithodus humer.* Germ., Sch. Curc. ii, 420; Lec. Pr. Ac. Nat. Sc. 1856, 18. Varieties? *Lithodus rectus, affinis, rudis, erosus* Lec. ibid, 18; *longior morbillosus* Lec. ibid., 19.

Digitized by Google

Family V. OTIORHYNCHIDÆ.

Mentum variable, sometimes large, filling the gular emargination and without peduncle, or small exposing the maxillæ and ligula and with distinct peduncle.

Labial palpi very rarely visible and then very short.

Mandibles short, stout, pincer-like, very rarely slightly scissor-like, and in one instance (*Dirotognathus*) slightly laminiform and prominent. Anterior face with a distinct scar frequently borne at the tip of a slight process.

Antennæ inserted at the sides or top of rostrum always in front of middle and usually near the tip, geniculate, 11-jointed (except in *Agraphus*), the last three forming a compact club with distinct evidences of the sutures.

Head moderately prominent, rarely (*Agasphærops*) deeply inserted; beak variable, never long and slender. Scrobes well defined, except in *Otiorhynchini*, and receiving the first joint (scape) of the antennæ in repose.

Prothorax of variable form, apex usually truncate; rarely slightly prolonged over the head, base truncate, arcuate or bisinuate, post ocular margin either truncate or with ocular lobe more or less developed, sometimes with stiff fimbriæ. Anterior coxæ contiguous (except in *Pandeletejus*).

Mesosternum short, oblique or horizontal, rarely (*Coleocerus*) protuberant; middle coxæ narrowly separated; side pieces variable, never attaining the coxal cavity.

Metasternum variable, short in Division I, usually long in Division II.

Elytra concealing the abdomen entirely from above, without trace of epipleuræ but with inflexed fold on their inner side.

Abdomen with five ventral segments, the first two connate, the others free. Intercoxal process variable.

Legs moderate; femora very rarely decidedly clavate; tibiæ straight or feebly arcuate, usually mucronate at tip and rarely with small spur-like processes (certain *Otiorhynchini*). Claws fixed or moveable, always simple, never toothed.

The males of all the species have the pygidium divided, so that there are eight dorsal segments, while in the female there are but seven.

This family contains all those genera in which the mandibles are provided in the pupa stage with a deciduous piece of varying form, usually elongate and slender, sometimes falcate and acute or short and conical. In the early life of the imago these pieces are lost (although specimens occur in which one, sometimes both are preserved), and the place of their attachment is indicated by a scar which is usually on the face of the mandible but frequently borne at the tip of a process of varying length. The form of the mandible itself without reference to the scar, indicates the occurrence of the deciduous piece. When the mandibles are acute at tip and one overlaps the other by an edge more or less acute, no deciduous piece can be expected. Its occurrence may always be looked for in those in which the mandibles meet with a broad surface and whose function is rather that of crushing than cutting. *Brachycerus*, *Sitones*, *Alophus* and all the *Mecorhynchi* are

Digitized by Google

instances of the former, while *Cyphus, Entimus, Leptops, Ophryastes, Tanymecus*, etc., illustrate the latter form.

The family Otiorhynchidæ as defined by Dr. Leconte (American Naturalist, 1874, p. 396), has but little to do with the tribe of the same name as restricted by Lacordaire (Genera vi, pp. 20 and 144), as it includes not only the greater portion of the Adelognathes, but also several tribes of Phanerognathes in the system of the latter author.

In examining the under side of the body two forms of construction are found, by means of which this large family may be divided into two primary sections.

1


First. Side pieces of mesosternum very unequal, the episternum larger and attaining the elytral margin, epimeron usually small, sometimes very small. Metasternal side pieces never very wide, generally very narrow or entirely concealed by the elytral margin, anterior end never broadly dilated on both sides.

Second. Side pieces of mesosternum diagonally divided and equal or very nearly so, episternum distant from the elytral margin, separated by the epimeron. Metasternal side piece moderately wide, dilated at its anterior end with an acute process of greater or less extent projecting inwards between the mesosternal epimeron and the body of the metasternum.

2


The accompanying wood cuts have been drawn natural size from (1) *Eupagoderes speciosus* Lec., and (2) *Hippoleptops tribulus* Fab., the latter from a specimen kindly sent by Mr. H. Jekel, which although foreign (New Holland), was of sufficiently large size to allow of the drawing being made natural size. In the cut the mesosternal epimeron is left entirely black that its position as well as the form of the adjacent parts, might be rendered more evident.

An examination of the foreign genera in the cabinet of the Academy of Nat. Sc., Phila., shows that the use of the above characters may be extended to genera not represented in our fauna, and by means of them foreign genera, evidently allied, may be brought in much closer proximity than by the system adopted by Lacordaire.

No genus in our fauna presents any extraordinary or anomalous characters. It may be remarked that no native species yet known is provided with any femoral armature, and all our genera with the exception of *Agraphus* have seven joints in the funicle of the antennæ.

By reference to the synoptic tables, the extent of variation in other portions of the body may be ascertained.

In consequence of the definition of the present family by the presence of the mandibular scar, the primary characters made use of by Lacordaire sink into even less than secondary importance, and as we have in the TENEBRIONIDÆ parallel series each with genera of maximum and minimum development of mentum, so we have in the *Rhynchophora* similar parallels in the two divisions above indicated.

In taking the structure of the sternal side-pieces as a primary means of

Digitized by Google

dividing this family, I have found that genera are thereby approximated which are now widely separated, and of which the best authorities on the subject since Lacordaire acknowledge the affinities. I might cite *Leptops* and *Entimus* in their approximation to *Cyphus* and *Rhigus*, the separation of *Brachystylus* from the Otiorhynchi and its position near *Cyphus* as well as *Artipus* from its present very unnatural position to a place near *Cyphus*. The character is therefore suggested as a better method of subdivision, although it is not claimed that it will in all cases be found infallible. A very limited study of the Rhynchophora will soon produce a conviction that there is on the one hand a great permanency of type of construction, and when variation of detail does occur, it is so gradual as to leave no abrupt lines of division.

DIVISION I.

This division contains those genera in which the mesosternal epimera are small, or at most moderate, the episterna in contact with the elytral margin, the metasternal side-pieces rarely of more than moderate width and not dilated at anterior end, and without the triangular process projecting between the mes-epimera and the metasternum. The other characters of the division are extremely variable, in all, however, the antennæ are strongly geniculate. All the genera of this Division in our fauna have a large mentum concealing entirely the maxillæ, excepting in the last tribe.

The following tribes are represented in our fauna:

Thorax without ocular lobes.

Antennal grooves (scrobes) lateral directed inferiorly.......... **BRACHYDERINI.**

Antennal grooves short, superior, rarely lateral, and then directed toward the eyes ...... **OTIORHYNCHINI.**

Thorax with ocular lobes more or less distinct.

Mentum at least moderate, concealing in great part or entirely the maxillæ. Mandibles robust not prominent, scar very evident........ **OPHRYASTINI.**

Mentum very small, maxillæ exposed, mandibles prominent, free edge rather thin, scar small, very narrow.......... **DIROTOGNATHINI.**

As will be seen by the above table the presence or absence of ocular lobes affords the only means of separating the tribes *Brachyderini* and *Ophryastini*, and the character must be strictly interpreted. The latter tribe has the ocular lobes sometimes very feeble and almost wanting, but as the lobes disappear the fimbriæ become more evident. In the former tribe there are no evidences whatever of either ocular lobes or fimbriæ. In one genus, the prosternum is more emarginate than usual, giving an appearance of slight ocular lobes, but no traces whatever of fimbriæ are seen. In some of the genera of *Ophryastini*, the metasternal side pieces become of moderate width, showing somewhat of an approximation to the

Digitized by Google

genera of the second division. The side pieces in the other two tribes are very narrow and the sutures nearly always obliterated.

Tribe I. BRACHYDERINI.

Rostrum at least as long as the head and slightly dilated at tip, which is more or less emarginate. Front flat, rarely with a slight depression between the eyes. Scrobes moderately deep, usually distinctly limited and very oblique. Antennæ moderate, scape attaining the eyes rarely (*Trigonoscuta*) passing them. Thorax without ocular lobes or fimbriæ and not or very feebly emarginate beneath. Scutellum usually distinct. Elytra oval, not wider than the thorax. Mesosternal epimeron small, episternum attaining the elytra. Episternum of metasternum narrow suture usually distinct in its entire length. Abdomen with the first two segments (except in Gr. iv), separated by an arcuate suture, segments 3–4 short, conjointly not or but little longer than the second.

As thus constituted, the tribe is widely different from that defined by Lacordaire under the same name. From it those genera have been removed in which the mesosternal side pieces are diagonally divided and the metasternal episterna moderately wide and dilated in front. These form tribes in the next division. It is, however, extremely difficult to fix tribal limits with any degree of certainty, as every character upon which classification has been based, exhibits a degree of variability almost unparalleled in any other series of Coleoptera. The ocular lobes of the thorax especially exhibit this tendency, and the pointed outline of the eye which usually accompanies the lobe is by no means in better condition. The eye may be more nearly circular in outline with a lobe than it is without the lobe.

As thus constituted, the tribe contains the following groups :

Third joint of all the tarsi wider than the second and deeply bilobed. Tibiæ normal, not dilated at tip. Scape not passing the eyes.

Posterior coxæ small, very widely separated......... **Minyomeri.**

Posterior coxæ normal intercoxal process triangular or oval.

Antennæ scaly, body beneath densely scaly. Elytra emarginate at base, thorax closely applied......... **Epicaeri.**

Antennæ shining, sparsely hairy, body beneath nearly naked.

Tips of hind tibiæ feebly cavernous, a double row of spinules. First abdominal suture arcuate... **Barynoti.**

Tips of hind tibæ open, a single row of spinules. First abdominal suture straight or nearly so .. **Hormori.**

Anterior tibiæ dilated at tip ; scape long, passing the eyes .... **Trigonoscutæ.**

Third joint of tarsi not wider than second, and feebly emarginate.. **Calyptilli.**

Digitized by Google

Group I. Minyomeri.

Rostrum stout, cylindrical, as long as the head, and very little narrowed to the tip. Scrobes deep, well defined, suddenly arcuate in front, gradually wider behind and passing beneath the eyes. Mesosternal side pieces unequal. Metasternal episternum linear, suture distinct. Intercoxal process very broad and very short. Hind coxæ very small. Corbels of hind tibiæ open, tarsal claws free.

The form of the head, rostrum and scrobes resembles considerably that of *Pandeletejus* of the Second Division, but the structure of the sternal side pieces excludes the present genus from any such association. According to the system adopted by Lacordaire, this genus would be placed in the *Brachydérides vrais*.

MINYOMERUS n. g.

Rostrum as long as the head, continuous with it and but slightly narrowed toward the tip, robust, slightly arcuate, feebly emarginate at tip. Head feebly transversely impressed behind the eyes, which are small, round and coarsely granulated, convex, but not prominent, scrobes moderately well defined, deep and suddenly flexed in front, gradually broader behind and passing beneath the eyes. Antennæ moderate; scape slender gradually clavate, slightly passing the middle of the eye; funicle 7-jointed, first two joints longer, the first longer than the second and stouter, 3–7 short and feebly broader externally; club elongate, oval, pointed. Thorax cylindrical, truncate at apex and base, without trace of ocular lobes or fimbriæ. Scutellum invisible. Elytra oblong oval, base truncate at middle, humeri broadly rounded. Middle coxæ moderately separated. Mesosternal side pieces unequally divided, elytra and episterna contiguous. Metasternal episternum very narrow, linear, suture distinct. Metasternum short. Posterior coxæ small, very widely distant. Intercoxal process very short. Second abdominal segment as long as the two following united, separated from the first by a suture arcuate at middle. Front and middle tibiæ feebly mucronate at tip, corbels of hind tibiæ open. Tarsi with coarse hairs beneath, third joint feebly bilobed. Claws free. Body densely scaly.

The feeble transverse impression of the head behind the eyes is a character of extremely rare occurrence, which is found also in *Proictes*, Sch. Some relationship might be expected between the two genera. I have not been able to inspect many of the genera belonging to the group *Brachydérides vrais*, but from those seen, I am inclined to think that nearly all should be referred to the Second Division of this memoir.

Two species are known to me:

Thorax slightly broader than long, sides moderately arcuate .... **innocuus.**
Thorax as long as wide, slightly narrower behind........... **languidus.**

Digitized by Google

M. innocuus, n. sp.

Form oblong oval, moderately densely scaly. Head and rostrum as long as the thorax, densely scaly and with very short erect hairs. Rostrum emarginate at tip and with small triangular depressed space; slightly swollen in front of the eyes. Occiput with transverse impression. Thorax broader than long, sides moderately arcuate, disc moderately convex, surface rugoso-punctate, sparsely scaly and with few short erect hairs. Elytra oblong oval, with rows of coarse shallow punctures closely placed, intervals feebly convex and at base feebly alternating; surface densely scaly and with indument, intervals with a row of very indistinct erect scale-like hairs. Body beneath densely scaly. Legs densely scaly and with sparsely placed short erect setæ. Length .14 inch; 3.5 mm.*

The scales are of a greyish or cinereous color, those of the thorax darker.

One specimen, Colorado.

M. languidus, n. sp.

Form elongate oval, surface densely covered with cinereous scales. Head and rostrum as long as the thorax. Head transversely impressed behind the eyes. Rostrum feebly emarginate at tip and with slight oval smooth space, surface densely scaly and with few short scale-like hairs. Thorax slightly longer than wide cylindrical, base narrower than the apex, sides nearly straight, apex and base truncate, disc regularly convex, coarsely, deeply and densely punctured, and with a slight median line. Elytra oblong oval, disc obsoletely striate, striæ with rather large, closely placed punctures, intervals slightly convex, densely scaly and each with a single row of very short scale like hairs. Body beneath and legs as in the preceding species. Length .14 inch; 3.5 mm.

Two specimens, Arizona and Fort Tejon, Cal.

In both species the deciduous piece has left a very inconspicuous scar, transversely oval in form and not prominent as in several of the following groups. I have not seen specimens with the pieces remaining. The mentum fills completely the gular emargination which is nearly semicircular in form. The genæ are notched opposite the bases of the mandibles. The distance between the posterior coxæ is equal to the length of the first two abdominal segments, and the coxæ are not larger than those of the middle pair.

Group II. Epicaeri.

The species composing this group are more or less pyriform, the body above and beneath densely scaly, the elytra of a pale-brownish or luteous color with the tip and two sinuous bands much paler. The rostrum is rather stout, usually longer than the head, the scrobes deep, well defined,

* The measurements here given as well as all to follow in the present paper, are taken from the apical thoracic margin to the tip of the elytra, as this is more certain and invariable than if the measurements are taken from the tip of the beak, which varies in length.

Digitized by Google

and rapidly descending. The supports of the deciduous pieces of the mandibles are moderately or very prominent.

The genera known to occur in our fauna may be recognised by the following table:

Articular face of hind tibiæ glabrous, support of deciduous piece moderately prominent.
  Antennæ stout, last joint of funicle short broad, and very close to the club. Joints 1–2 of tarsi, glabrous........................ **GRAPHORHINUS.**
  Antennæ more slender, joints of funicle conical, the last distant from the club. Tarsi pubescent................................ **EPICÆRUS.**
Articular face of hind tibiæ scaly. Support of deciduous piece very prominent. Antennæ rather slender, club distinct......... **ANOMADUS.**

The deciduous pieces of the mandibles are shown in one species of *Epicærus*. They are falciform, moderately robust, obtusely pointed, with the upper inner side concave, smooth and shining.

GRAPHORHINUS Sch.

Graphorhinus Schönherr, Gen. Curc. i, p. 510; indicated but not described by Say.

This genus has all the essential characters of *Epicærus*, and differs only in the following particulars:

Antennæ shorter, scape slightly clavate, attaining the eyes, funicle 7-jointed, first two joints slightly larger than the others, 3–6 as broad as long, the seventh broader than long, and in close proximity to the club, the latter broadly oval and pointed at tip. Eyes nearly round, slightly transverse. Cotyloid cavities of hind tibiæ terminal (*corbeilles ouvertes*) and glabrous, tarsi beneath glabrous slightly fimbriate near the tips.

By the above characters it will be seen that the genus differs from *Epicærus* in the form of the antennæ, the form of the posterior cotyloid cavities and the vestiture of the tarsi. The species below being the type of the genus, and as it differs in several particulars from the *Graphorhinus* as described by Lacordaire from other species, these should constitute another genus differing in the form of the antennæ and the vestiture of the tarsi.

G. vadosus Say, Curcul. p. 8; Am. Ent., p. 267; Gyll. Schönh. Gen. Curc. i, p. 511.

Body pyriform robust. Rostrum robust, quadrangular, slightly longer than the head, tip feebly emarginate and with a smooth triangular space limited behind by a chevron-like ridge behind which is a groove, above trisulcate and a moderately deep transverse impression between the eyes, median sulcus broad, lateral sulci short but deeper; surface densely clothed with cinereous scales and sparsely punctured. Thorax slightly broader at base than long, sides arcuate converging to the apex, which is truncate,

Digitized by Google

base arcuate; median line distinct, surface coarsely punctured and irregular, densely clothed with cinereous scales. Elytra broadly oval, very curved, slightly broader at base than the thorax, indistinctly striate, striæ with moderately coarse punctures, intervals alternately more convex, subcostiform, surface densely scaly, scales cinereous with a narrow triangular basal space, submedian and subapical transverse bisinuous fascia of darker color. Body beneath coarsely but sparsely punctured, densely scaly. Legs densely scaly. Tarsi glabrous beneath. Length .28–.38 inch; 7–10 mm.

This species has the same style of coloration as is seen in *Epicærus*, but the darker elytral fasciæ are at times absent.

Occurs in Kansas and Texas, and is not rare.

EPICÆRUS Sch.

Epicærus Schönherr, Gen. Curc. ii, p. 323.

Rostrum as long or slightly longer than the head, and nearly as broad, parallel, feebly canaliculate along the middle, tip feebly emarginate and with a triangular smooth space limited by an arcuate groove. Scrobes moderately deep, well defined, passing immediately beneath the eye and moderately arcuate. Eyes slightly longitudinally oval. Antennæ moderately long, scape gradually clavate, attaining nearly the middle of the eye; funicle 7-jointed, joints obconical, 1–2 moderately elongate, 3–4–5 nearly equal, 6–7 very slightly longer than last, not close to the mass which is elongate oval. Thorax variable, conical or cylindrical and narrowed in front. Scutellum very small. Elytra oval, broadly but feebly emarginate at base. Legs moderate. Tarsi spongy pubescent beneath. Body pyriform or elongate, densely scaly. Cotyloid cavities of hind tibiæ internal, glabrous, tip of tibiæ truncate. First suture of abdomen arcuate at middle.

Two species of Epicærus occur in our fauna.

Thorax not wider at base than at middle, form more or less elongate, narrowed at middle.................... **imbricatus.**

Thorax conical widest at base, body pyriform......... **formidolosus.**

E. imbricatus Say, Journ. Acad. 1824, p. 317; Germ. Sch. Gen. Curc. ii, p. 267; Bohem. Sch. Gen. Curc. vi, 2, p. 280.

Form variable. Rostrum feebly sulcate at middle and with a slight preocular impression, surface sparsely punctured densely scaly. Vertex with impressed puncture. Thorax cylindrical narrowed at anterior third, surface with deeply impressed punctures in great part concealed by densely placed scales, cinereous along the middle, darker at the sides. Elytra not striate but (when denuded) with rows of large deep punctures, surface densely scaly, color cinereous, with basal space, submedian irregular, and subapical sinuous fasciæ darker in color. Body beneath and legs densely scaly, scales nearly white. Length .30–.46 inch; 7.5–11.5 mm.

This species occurs in every portion of our territory east of the Rocky Mountains and south and west of Pennsylvania, and exhibits a very great variation in form and coloration. The elytra may be elongate oval or

Digitized by Google

broadly oval, and the tip vertical or inflexed, sometimes compressed, like the prow of a vessel. In color the surface may vary to entire cinereous or even in great part fuscous.

E. formidolosus Boh. Schön. Gen. Curc. vi, 2, p. 284.

Body ovate. Rostrum feebly sulcate at middle, pre-ocular impressions very faint, vertex with impressed puncture; surface sparsely punctured and densely clothed with pale cinereous scales. Thorax conical, sides feebly arcuate, shorter than broad at base, surface sparsely punctured, densely scaly. Elytra broadly oval, sub-inflated, but little longer than wide, with rows of moderate punctures not closely placed, surface densely scaly with very short semi-erect scale-like hairs in the intervals. Body beneath and legs densely scaly. Length .16–.26 inch; 4–6.5 mm.

The depth of the median rostral groove varies greatly in the specimens before me. The elytra continue very nearly in their curve the line of the sides of the thorax, and their color above is almost precisely that of the preceding species. Two specimens before me are totally cinereous, and two others fasciate. The erect scale-like hairs of the intervals while very distinct in the present species, are very indistinct in the preceding, so that no special mention is made of them.

The specimens before me are from Georgia and Florida.

ANOMADUS n. g.

Rostrum as long as the head and not narrower, sub-cylindrical, slightly dilated at tip; tip triangularly emarginate and with a smooth space. Scrobes deep, arcuate, passing slightly in front of the eye. Antennæ sub-terminal, long; scape gradually clavate; funicle 7-jointed, joints 1–2 moderately long, nearly equal, joints 3–6 short, equal, joint 7 slightly longer and distant from the club which is elongate oval. Eyes oval, slightly longitudinal. Thorax cylindrical, sides moderately arcuate. Scutellum very small. Elytra regularly oval, conjointly emarginate at base, not wider than the thorax, humeri rectangular. Legs moderate, femora slightly clavate, tibiæ straight. Cotyloid cavities of hind tibiæ internal, scaly, tip of tibia truncate.

The supports of the deciduous mandibular pieces are much more prominent in this than in any other genus in the tribe. Following the system of Lacordaire one would be compelled to call this genus *Artipus*. This latter cannot however be placed in the present tribe, or even in this first division as the form of the meso- and metasternal side pieces agree with the genera allied to *Cyphus* as will be seen further on.

A. obliquus, n. sp.

Body oblong, narrower at middle. Rostrum very sparsely punctured, densely clothed with scales of pearly lustre, darker at the sides, with few erect scale-like hairs. Thorax slightly longer than wide, moderately convex, cylindrical, truncate at apex and base, sides arcuate, surface coarsely but sparsely punctured densely scaly, at middle pearly, at sides fuscous. Elytra

Digitized by Google

regularly oval, convex, with rows of moderate punctures not closely placed, surface densely scaly with short setæ distantly placed in the intervals, scales pale cinereous with a common basal triangular space as long as wide, a very oblique fascia extending from behind the humeri to the suture, and an indistinct transverse sub-apical fascia all fuscous. Body beneath and legs densely clothed with pearly scales with short setæ sparsely interspersed. Length .20 inch ; 5 mm.

This insect reproduces exactly the form or coloration of some of the smaller specimens of *Epicærus imbricatus*.

One specimen from the Peninsula of Lower California.

Group III. **Barynoti.**

Rostrum moderately stout, longer and slightly narrower than the head, sub-cylindrical, slightly dilated at tip which is slightly notched, upper side finely sulcate. Scrobes deep, slightly arcuate passing immediately beneath the eyes, which are large, oval, and slightly oblique. Scape slightly clavate, attaining the middle of the eye, surface glabrous and slightly ciliate ; funicle 7-jointed, joints 1–2 longer, joint 3 conical, 4–7 rounded, club elongate oval. Thorax subquadrate, slightly narrower in front, apex truncate, base slightly arcuate. Scutellum small. Elytra moderately oval, convex, base broadly emarginate and slightly wider than the thorax, humeral angles distinct in front. Thighs moderately clavate, anterior tibiæ slightly arcuate, middle and posterior slightly dilated at tip, all slightly mucronate. Hind tibiæ with a double row of fimbriæ surrounding an oval smooth space (*corbeilles caverneuses*). Tarsi moderately dilated, pubescent beneath, claws free.

BARYNOTUS Germ.

Barynotus Germ. Ins. Spec. Nov. p. 337.

This genus alone represents this group in our fauna containing one spe cies which occurs also in Europe.

B. Schœnherri Zetterst. Ins. Lapp. I, p. 187 ; Bohem. Schön. Gen. Curc. vi, 2, p. 250.

Head and rostrum as long as the thorax, rather coarsely and deeply but sparsely punctured, sparsely pubescent at sides and tip. Thorax sub-quadrate, sides behind parallel, anterior third convergent, apex truncate, base broadly arcuate ; surface moderately deeply punctured, punctures moderately coarse with finer punctures in between, at sides punctures coarser and deeply circumvallate ; median line finely impressed ; surface sparsely clothed with pearly scales. Elytra slightly broader at base than thorax oval, moderately convex, base broadly emarginate, surface clothed with scales of pearly lustre with intermixture of cupreous and greenish scales, and with rows of moderately coarse punctures ; intervals alternately slightly more convex and (where denuded) moderately densely punctulate. Body beneath coarsely, densely aud deeply punctured and sparsely pubescent, the pubescence denser on the metasternal side pieces. Legs black sparsely punctured. Length .33 inch ; 8.25 mm.

Digitized by Google

One specimen from the south of Newfoundland given to Dr. LeConte by M. Putzeys, of Brussels. The specimen is nearly entirely deprived of scales and black.

Group IV **Hormori.**

Rostrum longer and narrower than the head, subcylindrical at base, broader at tip, alæ moderately divergent, apex emarginate and with a V shaped elevated line, median line distinctly impressed. Scrobes deep in front, and moderately arcuate, posteriorly feebly marked and directed beneath (*Hormorus*) or toward the lower border of the eye (*Agasphærops*). Antennæ moderately long, attaining the middle of the eye in the former and barely reaching the eye in the latter. Eyes moderately or very prominent. Metasternal side pieces almost entirely concealed by the elytra; metasternum short. Intercoxal process broad, truncate, second abdominal segment but little longer than the third and separated from the first by a straight suture. Corbels of hind tibiæ open, claws of tarsi free.

The supports of the deciduous pieces of the mandibles are very prominent, obliquely truncate and pointed at tip; the deciduous pieces do not exist on any of the specimens before me. The open posterior corbels and the straight first abdominal suture would seem to place the two genera here included in Lacordaire's *Blosyrides* with which, however, they have but little in common.

Two genera are thus separated:

Scape attaining the middle of the eyes, the latter moderately prominent, without posterior orbit. **HORMORUS.**

Scape barely attaining the anterior margin of the eye, the latter spherical, prominent and with posterior orbit............................ **AGASPHÆROPS.**

These two genera have the elytra at base feebly emarginate and somewhat broader than the thorax, the humeri being broadly rounded in the latter and subrectangular in the former genus. There is also a close superficial resemblance to *Otiorhynchus*, especially in the second, where the surface is black and with few and inconspicuous scales. *Hormorus* is however more ornate as will be seen in the description. I have endeavored to find genera to which these are allied, but with the work of Lacordaire and the limited foreign collection at my disposal I am entirely unable to do so, I must therefore describe them so far as to make them recognizable in our fauna and leave their relationships for future determination.

HORMORUS n. g.

Rostrum longer and narrower than the head, cylindrical at base, slightly dilated at apex, alæ moderately prominent, tip acutely emarginate and with a V-shaped line and on each side a groove, median line finely impressed, terminating in a broad shallow impression and between the eyes in a slight puncture. Mandibular processes prominent, obliquely truncate and acute at tip. Mentum slightly retracted, in great part concealing the other oral

Digitized by Google

organs. Eyes round, moderately prominent. Scrobes moderately deep in front, slightly arcuate and well defined, posteriorly vague and passing immediately beneath the lower margin of the eye. Antennæ moderately long, scape gradually clavate, attaining the middle of the eye; funicle 7 jointed, the first two slightly longer and subequal, 3-7 obconical, the last slightly broader but distant from the club which is oval, acute and distinctly articulated. Thorax oboval, without ocular lobes or fimbriæ. Scutellum invisible. Elytra oblong oval, feebly emarginate at base and slightly wider than the thorax. Mesosternal process nearly vertical. Metasternum short, side pieces with distinct suture, but almost entirely covered by the elytra. Intercoxal process broad, truncate, second segment not as long as the two following united, separated from the first by a very nearly straight suture. Tibiæ mucronate, the anterior and middle denticulate within, corbels of hind tibiæ open, glabrous, tarsi normal, claws free, Body above sparsely scaly in irregular bands and patches.

H. undulatus Uhler (*Chlorophanus*) Proc. Acad., 1855, p. 416.

Form elongate oval, dark brown, ornate with pearly scales. Head and rostrum as long as the thorax, moderately densely punctured, sparsely covered with pearly scales and recumbent scale-like hairs. Thorax slightly longer than wide, broadest in front of middle, sides arcuate in front, slightly convergent towards the base, apex truncate and with feeble constriction behind the margin, disc moderately convex, median line distinctly impressed, surface coarsely and closely tuberculate, each tubercle punctured at summit and with a scale-like hair, lateral margin with a narrow line of pearly scales. Elytra oblong oval, narrower in the male, disc moderately convex, suddenly declivous at apex, surface with striæ of large, deep, closely placed punctures, intervals narrower and with granules moderately elevated; surface ornate with pearly scales, arranged in the form of a humeral lunule and an irregular patch on each side of the declivity. Body beneath densely punctured, sparsely covered with scale-like hairs and with a patch of pearly scales on each side of metasternum. Legs piceous, sparsely hairy, femora with few scales near the tip. Length .30 inch; 7.5 mm.

Occurs in Canada, Maryland, Illinois.

AGASPHÆROPS n. g.

Rostrum much longer than the head, cylindrical at base, dilated in front, alæ prominent, above with deep median groove, tip feebly trisinuate, a V-shaped elevated line and on each side a broad groove. Supports of deciduous pieces prominent, obliquely truncate and acute at tip. Mentum filling the gular emargination. Scrobes deep and visible from above in front, feebly arcuate, gradually feebler posteriorly and passing immediately beneath the eyes. Antennæ moderate, scape short, moderately robust, gradually clavate, nearly attaining the anterior margin of the eye; funicle 7-jointed, one and a-half times the length of the scape; joints 1–2 sub-equal, longer than the others, 3–7 short, obconical; club oval. Eyes round.

Digitized by Google

prominent, surrounded by a moderately deep orbital groove. Head short, deeply inserted, hemispherical. Thorax without ocular lobes or fimbriæ. Scutellum invisible Metasternum short, side pieces nearly concealed, suture distinctly visible. Intercoxal process broad, feebly arcuate in front, second abdominal segment as long as the two following united, separated from the first by a straight suture. Anterior and middle tibiæ feebly mucronate, corbels of hind tibiæ open, tarsi normal, claws free.

The general aspect of the unique species is such that, were the scapes of the antennæ long, I would have placed the genus in Otiorhynchini.

A. nigra, n. sp.

Elongate oval, *Otiorhynchus*-like, black, sub-opaque. Head and rostrum as long as the thorax. Rostrum deeply grooved at middle, coarsely punctured and glabrous. Antennæ piceous. Thorax cylindrical, as long as wide, sides moderately arcuate, disc convex, surface with coarse closely placed tubercles, each perforated at summit and bearing an indistinct scale. Elytra oval, base feebly emarginate and wider than the thorax, humeri broadly rounded, disc moderately convex, surface with rows of coarse, sub-quadrate punctures, intervals with flattened tubercles each perforated and with an indistinct scale. Body beneath black glabrous, coarsely and densely punctured. Legs black, more sparsely punctured. Length .30 inch; 7.5 mm.

Two specimens. Mendocino, Cal.

Group V. **Trigonoscutæ.**

Anterior tibiæ with the outer apical angle prolonged. Articular surfaces of hind tibiæ strongly cavernous and scaly.

TRIGONOSCUTA Motsch.

Trigonoscuta Motsch. Etudes Entomol. I, 1852, p. 79.

Rostrum sub-cylindrical, slightly longer and narrower than the head. separated from the head by a fine impressed line, above finely canaliculate, tip truncate. Scrobes deep, arcuate, passing near the lower margin of the eyes. Antennæ moderately long; scape gradually clavate, passing the eyes posteriorly; funicle 7-jointed, 1–2 longer sub-equal, 3–7 obconical, gradually shorter and broader, club oval. Eyes oval, slightly oblique. Thorax sub-tranverse, truncate at base and apex. Scutellum small, triangular. Elytra oval ♂ or broadly oval ♀, humeri rounded. Legs moderate, femora moderately clavate, anterior tibiæ dilated at tip, and with the middle tibiæ slightly swollen at middle; hind tibiæ very obliquely truncate, the articular surfaces cavernous and scaly. Tarsi spongy and villous beneath, median line glabrous last joint long, claws moderate, free. Intercoxal process very broad, slightly rounded in front. Second segment of abdomen longer than the two following united, separated from the first by an arcuate suture. Body scaly and hairy.

The supports of the deciduous pieces are not prominent. These pieces are rather long, very feebly arcuate and obtuse at tip. The generic des-

Digitized by Google

cription given by Motschulsky is so extremely vague and short as to be entirely valueless, and in strict justice the genus should be credited to Lacordaire.

T. pilosa Motsch. Etudes Entom. I, 1852, p. 79; Lacord. Genera, Atlas pl. 61, fig. 5, a–b.

Form oval, robust, surface densely covered with cinereous scales and moderately long greyish hairs sparsely placed, elytra irregularly variegated with fuscous. Head and rostrum as long the thorax, densely scaly and sparsely pilose. Antennæ rufous, hairy. Thorax broader than long, narrower in front, sides strongly arcuate, disc convex, surface moderately densely scaly. Elytra rather broadly oval, humeri broadly rounded, sides feebly arcuate and slightly acuminate posteriorly, disc convex, with rows of moderately fine punctures, surface densely scaly and sparsely pilose. Body beneath moderately densely scaly and with rather longer hairs than the upper surface, last three segments of abdomen distinctly pubescent. Legs more sparsely scaly and with rather long greyish hairs. Length .22—.36 inch; 5.5—9 mm.

The males have the metasternum and abdomen broadly concave. The scales covering the elytra and, in fact, the entire upper surface are very variable in coloration. The ground color is a cinereous usually very irregularly mottled with fuscous. Occasionally specimens occur in which the elytra are pale ochreous with an irregular band on the middle of each elytron becoming gradually broader behind, nearly uniting at the suture.

This species is not rare on the sea-coast at San Francisco, Cal.

Group VI. Calyptilli.

Rostrum not longer than the head, sub-quadrangular, very slightly narrowed toward the tip and but little narrower than the head. Eyes round, coarsely granulated and almost entirely concealed from above by a small tubercle. Scrobes lateral, arcuate, deep. Thorax without ocular lobes or fimbriæ. Scutellum very indistinct. Mesosternal side pieces very unequal. Metasternum short, side pieces moderate, suture obliterated. Abdomen normal, intercoxal process broad truncate in front. Tarsi with coarse spinous hairs beneath, third joint not wider than the second and feebly emarginate, last joint moderately long, claws free. Anterior tibiæ feebly mucronate and digitate at tip with four or five coarse spinules, articular cavities of hind tibiæ cavernous.

The gular emargination is moderately large and without sub-mental peduncle. The mentum is nearly semicircular in shape and partially exposes the other oral organs, the maxillæ being slightly visible at the sides and the ligula at tip.

The combination of characters above given will be found very difficult to place in any tribe of Lacordaire's system. The genus can not be called *Phanerognath*, as the mentum conceals the greater portion of the oral organs, and I am equally at a loss for a position in the *Adelognath* series.

The occurrence of narrow tarsi in this portion of the series is certainly

Digitized by Google

a remarkable circumstance and serves to illustrate the almost utter impossibility of dividing any portion of the Rhynchophorus sub-order without apparently doing violence to some important character. As the present is the first occurrence of this character, it might be here observed that two others always accompany it (in our fauna) viz.:—The approximation of the last joint of the funicle to the club and the tarsi more or less spinous beneath. *Ophryastes*, *Rhigopsis*, and *Cimbocera*, the only genera of Otiorhynchidæ in our fauna with narrowed tarsi, all have the other two characters. The tarsi may, however, be more or less spinous in other genera, but the antennal character never occurs without narrowed tarsi.

CALYPTILLUS n. g.

Rostrum not longer than the head, sub-quadrangular, slightly narrower in front, a feeble trace of transverse impression at base, above flat, tip broadly emarginate; head with a tuberculiform process over each eye. Scrobes deep, arcuate, well defined, passing beneath the eyes. Eyes round, moderately convex, coarsely granulated. Antennæ moderate, scape gradually stouter, slightly arcuate, passing the eyes behind; funicle 7-jointed, very little longer than the scape, first joint longer and stouter, second nearly as long; 3–7 short gradually broader, the last very close to the club, the latter oval, distinctly articulated. Thorax transversely oval, neither lobed nor fimbriate behind the eyes. Scutellum scarcely visible. Elytra broadly oval, base feebly emarginate, humeri broadly rounded. Femora rather feebly clavate. Tibiæ especially the anterior with coarse spinules at tip. Metasternum short. Second segment of abdomen as long as the two following, first suture arcuate at middle. Body densely scaly and hispid.

C. cryptops, n. sp.

Form broadly oval, densely covered with brownish cinereous scales, irregularly variegated with darker color. Head and rostrum as long as the thorax, densely scaly and with few short erect clavate hairs. Thorax oval, broader than long, apex and base truncate, sides regularly arcuate, disc moderately convex, surface granulato-punctate, sparsely scaly near the sides and with short erect clavate hairs. Elytra broadly oval, moderately convex, one-half wider than the thorax, humeri broadly rounded, sides feebly arcuate, apex obtuse, surface faintly striate, striæ with distant punctures, intervals flat, densely covered with brownish cinereous scales, irregularly clouded with darker color and each interval with a row of very short sub-erect scale-like hairs, slightly clavate. Body beneath covered as above. Legs sparsely scaly. Length .10 inch; 2.5 mm.

The form and general aspect of the species is that of a *Trachyphlœus*. The surface color deprived of scales is dark castaneous.

One specimen, New Mexico.

Tribe II. OPHRYASTINI.

This tribe as here interpreted, corresponds very nearly with the *Leptopsides* of Lacordaire, as far as our genera are concerned. Lacordaire in

Digitized by Google

cludes very heterogeneous material as must be evident to even a superficial observer. No one can deny the necessity of approaching *Entimus* and its allies to *Cyphus*, forming a distinct tribe, however, from the latter, and at the same time *Leptops* must be similarly dealt with, and should probably be placed with the *Entimides*. As far as I have studied the majority of the genera of the group *Leptopsides* vrais, should remain in the present tribe.

As *Leptops* belongs to my second division, I have been compelled to change the name of the tribe, and have adopted that of our most prominent genus.

As interpreted in the present paper, this tribe has the following characteristics :

Rostrum moderately or very robust, quadrangular or sub-cylindrical. Mandibles robust, never prominent or laminiform at tip, scar round, very distinct and sometimes prominent. Mentum large or at least moderate, concealing in great part the other oral organs, sub-mentum rarely feebly pedunculate. Scrobes lateral, rarely (*Phyxelis*) visible from above, directed either toward the middle of the eyes or inferiorly. Antennæ moderate, scape always attaining at least the eye, funicle 7-jointed, the last usually free, rarely (*Cimbocera* and *Ophryastes*) contiguous to the mass. Thorax always with distinct ocular lobes which are frequently fimbriate. Metasternum usually very short, side pieces usually narrow, suture nearly always visible. Mesosternal side pieces unequally divided, episternum and elytral margin contiguous. Intercoxal process at least moderately, sometimes very broad (*Rhigopsis*). Abdomen variable, second segment longer than the two following united (except in *Ophryastes*), and with the first suture arcuate (except in *Ophryastes* and some *Strangaliodes*). Tarsi variable, usually pubescent beneath, sometimes spinous ; third joint usually deeply bilobed and broader, rarely simply emarginate and not wider than the second, (certain *Ophryastes*, and in *Cimbocera* and *Rhigopsis*). Claws always free. Body always apterous.

The tribe contains moderately homogeneous material but with evident tendencies in some of the genera to closely approximate those of neighboring tribes, especially is this the case in those genera with the feebler ocular lobes. Thus *Phyxelis* approaches *Trachyphloeus* and *Phymatinus* to *Otiorhynchus*. There is very little tendency to approch DIVISION II, *Phymatinus* alone having the mesosternal side pieces nearly equally divided but the metasternal parapleuræ are not at all like those of that division.

The genera of the tribe form the following groups:

Rostrum robust, quadrangular, more or less distinctly trisulcate above.

Scrobes rapidly inferior, well defined. Eyes always narrow and acute below, partially concealed by the ocular lobes.

Abdomen with second segment rarely as long as the two following together, first suture straight. Intercoxal process moderately wide.. **Ophryastes.**

Digitized by Google

Abdomen with second segment longer than the two following together, first suture strongly arcuate. Intercoxal process very broad .... **Rhigopses.**

Rostrum less robust, sub-cylindrical, never sulcate above. Scrobes feebly inferior, usually directed toward the eyes or visible from above and badly defined. Eyes oval, not acute below and usually entirely free.

Scrobes entirely lateral .... **Strangaliodes.**

Scrobes visible from above .... **Phyxeles.**

The groups as above defined are very distinctly limited in our fauna, the last group alone being of doubtful value.

In this tribe, occur genera with the narrow third tarsal joint, which however, is not of the form seen in the BYRSOPIDÆ. This character will be spoken of at greater length in the genera in which it occurs.

Group I. **Ophryastes.**

Rostrum robust, angular, more or less distinctly trisulcate, tip feebly emarginate with a small triangular smooth space. Antennæ moderately robust, scaly, scape gradually thicker, nearly attaining the eyes, funicle 7-jointed, the last joint contiguous to the club which is oval. Scrobes deep, passing obliquely downwards in front of the eyes. Eyes oval, transverse, pointed beneath. Thorax variable in form, either oval or transverse, and with callosities at the sides. Elytra oval or oblong. Scutellum wanting. Abdominal sutures straight, second segment equal to, or very little longer than, the third. Tibiæ not mucronate at tip. Tarsi variable. Claws free.

The articular surfaces at the tips of the hind tibiæ are very nearly terminal and in great part scaly. Lacordaire calls them "*caverneuse*," but I think without reason (for the majority of the species). They are cavernous in some *Eupagoderes*. The mesosternal side pieces are very unequal, the epimeron being very small. The metathoracic episternum is moderately broad and the suture more or less distinct. In all the species the ophthalmic lobes are of moderate size and fimbriate. The surface of the body is densely scaly and without any pubescence.

Two genera appear to be indicated in our fauna.

Tarsi slender, third joint not wider than second, and simply emarginate. Sides of thorax with tuberosities more or less marked. Tips of tarsal joints beneath spiniform............................ **OPHRYASTES.**

Tarsi dilated, third joint usually wider than second and deeply bilobed. Thorax oval without tuberosities, tarsi beneath not spinous at tip... .... **EUPAGODERES.**

In the first genus the elytra are broadly oval, in the second elongate oval. In the latter also, the legs are longer.

Digitized by Google

OPHRYASTES Schönh.

Ophryastes Schönherr, Curcul., i, p. 508.

The species of this genus as restricted by the preceding table, are not numerous, and have a facies at once distinguishing them from the following genus. They are all of robust form, elytra rather broadly oval and the surface densely scaly, either cinereous or whitish, ornamented with stripes or spots of a much darker color. Considerable variation within specific limits is found, not only in color but also in form. All the species with but one exception, have at the base of the rostrum a distinctly marked transverse impression and the vertex thus appears convex. The tenth elytral stria in the larger species is very distinct at its basal third, and as distant from the ninth as the latter is from the eighth, at middle the stria is not evident, and at its apical third very close to the ninth. In the smaller species, in which also the thoracic tuberosities are very feeble, the tenth stria is entirely obliterated. The deciduous mandibular piece is moderately long, acute at tip, slightly arcuate. This piece when cast leaves merely a a scar without any process.

In accordance with the characters our species may be tabulated in the following manner:

Tenth elytral stria distinct at basal third. Thoracic tuberosities large..	1
Tenth elytral stria almost entirely obliterated. Thoracic tuberosities feeble...........................	2
1–Rostrum without transverse impression. Median groove attaining the occiput..............................	**vittatus.**
Rostrum with feeble transverse impression. Median groove attaining the front.......................	**tuberosus.**
Rostrum with very distinct impression. Median groove rostral only.......................................	**latirostris.**
2–Elytra produced at base, humeri very oblique......	**sulcirostris.**
Elytra truncate at base, humeri feebly prominent	**porosus.**

O. vittatus Say, (*Liparus*) Journ. Acad. iii, p. 316; Germ. Sch. Gen. Curc. i, p. 509; Lec. Proc. Acad. vi, p. 443; Lec., Col. Kansas, 1859, p. 18, pl. 1, fig. 13.

Rostrum trisulcate, lateral sulci extending from opposite the insertion of the antennæ to a point opposite the eye, deep, slightly arcuate above; median sulcus extending from the tip nearly to the occiput. Thorax nearly twice as wide as long, sides strongly divergent from apex and near base suddenly narrowed, median line distinctly impressed, surface deeply punctured and irregular. Elytra regularly or oblong oval, vaguely striate and with rows of moderate punctures, interspaces slightly convex, surface densely covered with cinereous scales, the sutural and alternate interspaces black. Body beneath and legs densely covered with whitish scales. Length .34–.52 inch; 9—13 mm.

This species may be at once distinguished by the sculpture of the head

Digitized by Google

and the vittate elytra It varies greatly in form primarily from sexual differences.

Occurs in Kansas and New Mexico. Not rare

O. tuberosus Lec. Proc. Acad. vi, p. 443.

Rostrum trisulcate, sulci rather broad and shallow, median passing slightly on the front, lateral extending above the eyes, transverse impression at base of rostrum feeble. Thorax nearly twice as wide as long, constricted at apex and base, sides (tuberosities) slightly divergent and notched at middle, surface deeply punctured and very irregular. Elytra regularly oval with rows of large, deeply impressed punctures; surface densely covered with cinereous scales and maculate with black. Body beneath and legs densely covered with whitish scales, femora with black spots near the tip. Length .40–.50 inch; 10–12 mm.

This species occurs rather abundantly in Colorado and New Mexico.

O. latirostris Lec., Proc. Acad. vi, p. 443; *validus* ♀ Lec., Proc. Acad. vii, p. 225.

Rostrum deeply transversely impressed at base (front convex) trisulcate, lateral sulci moderately deep, median sulcus broad, shallow, neither extending beyond the transverse impression. Thorax nearly twice as wide as long, anteriorly moderately at base suddenly and strongly constricted, sides divergent from apex feebly notched at middle; surface deeply punctured and very irregular. Elytra regularly oval, feebly ♂ or not ♀ striate with moderately impressed punctures. Body beneath and legs densely covered with whitish scales. Length .44–.64 inch; 11–16 mm.

The elytra are densely covered with cinereous scales, and with small irregularly interspersed fuscous spots, but to a much less extent than in the preceding species. From both the preceding species the present differs in the convex front, the rather deep transverse impression of the base of the rostrum as well as the form of the grooves. The thorax does not differ greatly in form in the three species, but is much less collared in this than in *tuberosus*. The median line is impressed in some and obliterated in other specimens.

Occurs in Kansas, New Mexico and Utah.

O. sulcirostris Say, (*Liparus*) Journ. Acad. iii, 1824, p. 316; Gyll. Sch. Gen. Curc. i, p. 509; Lec., Proc. Acad. vi, p. 443; *ligatus* Lec., loc. cit

Rostrum deeply transversely impressed at base, median sulcus moderate, lateral sulci short. Front convex. Thorax one-third wider than long, at apex moderately, at base strongly constricted, sides divergent from apex moderately tuberose, thorax deeply punctured and irregular. Elytra oval, humeri oblique, surface not or only obsoletely striate and with rows of moderate punctures, intervals feebly conxex; surface densely covered with pale cinereous scales maculate with fuscous, sometimes entirely plumbeous. Body beneath and legs densely covered with white or plumbeous scales Length .32–.36 inch, 8–9 mm.

Digitized by Google

The color of the surface vestiture varies greatly. In some specimens it is entirely plumbeous, in many cinereous obsoletely fusco-maculate, while in *ligatus* (a ♀) the fuscous spots are confluent and the elytra subvittate. The deciduous mandibular pieces are of slender conical form, very feebly arcuate and not long.

Occurs in Kansas, Colorado and Utah.

O. porosus Lec., Proc. Acad., 1845, p. 225.

Rostrum moderately transversely impressed at base, above trisulcate, median sulcus broad and shallow, lateral sulci short and deep. Thorax not twice as wide as long, sides with feeble tuberosity moderately arcuate, base moderately constricted; surface coarsely punctured and irregular, median line moderately impressed. Elytra oval, base truncate, humeri rectangular slightly broader than the thorax at base, with striæ of moderately large punctures, surface with plumbeous scales. Body beneath and legs covered with plumbeous scales. Length .36 inch; 9 mm.

This species and the preceding have the tenth elytral stria entirely obliterated, and the tuberosities of the thorax feeble, in both of which characters they differ from all the species which precede.

One specimen collected by Maj. Webb while on the boundary survey between the United States and Mexico.

EUPAGODERES, n. g.

This genus contains those species, formerly placed in *Ophryastes*, without lateral thoracic tuberosities. The tarsi are more dilated, the joints proportionately shorter and the third more distinctly bilobed. The distal angles are not produced in a spiniform process, a character by no means constant, however, in Ophyrastes. In this genus the articular cavities of the hind tibiæ become internal and the tip of the tibia truncate, showing an oval scaly space. The transition from the double apical fringe, which is usual, to the truncate tip with the two rows of fimbriæ surrounding an oval space is in this genus so gradual, even with the limited number of species, that it seems to indicate the little value of the characters drawn by Lacordaire from "*corbeilles ouvertes*" and "*corbeilles caverneuses.*" The deciduous mandibular piece is similar to that of *Ophryastes*. As in the latter genus some species have the rostrum and vertex continuous, the greater number, however, have a sinuation at the base of the rostrum. *O. Sallei* Sch. from Mexico belongs here.

The following are our species:

1—Vertex flat, rostrum without basal impression.
 Rostrum sulcate, thorax finely punctured.... .... **speciosus.**
 Rostrum sulcate, thorax coarsely and deeply punctured.. **sordidus.**
 Rostrum not sulcate, thorax coarsely and deeply punctured .... **decipiens.**

2—Vertex convex, rostrum with basal impression.
 Elytral striæ broad, punctures large and close.

Apex of hind tibiæ narrow, disc of thorax coarsely punctured.
Rostrum with three sulci, elytra oblong......... **argentatus.**
Rostrum with median sulcus only, elytra broadly oval.. **lucanus.**
Apex of hind tibiæ truncate with broad oval space.
Thorax rather finely punctured..................... **desertus.**
Elytral striæ fine, punctures coarse, thorax very coarsely and deeply punctured .... **varius.**
Elytral striæ fine, punctures fine.
Intervals unequal, elytra vittate........................ **geminatus.**
Intervals equal, elytra uncolorous.................... **plumbeus.**

In the species belonging to the first group the median sulcus of the rostrum extends on the front. In the second group the sulcus is rostral and extends to the transverse impression only.

E. speciosus Lec. (*Ophryastes*) Proc. Acad. vi, p. 444.

Form oblong, vertex flat. Rostrum without transverse basal impression, trisulcate, median sulcus extending from the tip to the front, terminating in a small fovea, lateral sulci on the sides of the rostrum, deep and angulated; surface sparsely punctured, densely scaly with white, middle and sides plumbeous. Thorax broader than long, sides rather strongly arcuate, apex and base with deeply impressed line at the sides, median line finely impressed; surface rather finely punctured, even, covered with dark plumbeous scales; on each side of middle an irregular white vitta. Elytra oblong oval, finely striate, striæ serrately punctured, intervals flat, unequal, surface densely covered with dark plumbeous scales, the narrower intervals and sides white. Body beneath and legs white. Length .74 inch; 19 mm.

One of the most conspicuous Rhynchophora in our fauna. The tenth elytral stria is composed of a few punctures close to the margin. The cotyloid cavities of the hind tibiæ are feebly cavernous and scaly.

Occurs in north-western Texas.

E. decipiens Lec. (*Ophryastes*) Proc. Acad. vi, p. 445.

Form oblong. Vertex not more convex. Rostrum without basal impression, median sulcus replaced by an obsolete fovea, lateral sulci very short; surface sparsely punctured, densely covered with whitish scales. Thorax not broader than long, sides strongly arcuate, apex and base truncate, surface deeply perforato-punctate, not uneven. Elytra oblong oval, finely striate, striæ with rather distant punctures, intervals equal, flat, surface densely covered with dark cinereous scales. Body beneath and legs white. Length .28–.44 inch; 7–11 mm.

Posterior cotyloid cavities strongly cavernous. This species may be easily known by the sculpture of the rostrum.

Occurs in Texas, New Mexico and Arizona.

Digitized by Google

E. sordidus Lec. (*Ophryastes*) Proc. Acad. vi, p. 445.

Form oblong oval. Rostrum trisulcate, median sulcus attaining the base of the rostrum, lateral sulci deep and straight, no transverse basal impression. Thorax slightly broader than long, sides moderately arcuate, base and apex truncate, surface sparsely punctured and slightly uneven. Elytra oval, striæ replaced by rows of moderate punctures, intervals equal, surface densely covered with cinereous scales and obsoletely maculate. Body beneath and legs nearly white. Length .36 inch ; 9 mm.

This species resembles the preceding but is less elongate, the elytra wider at base, and the rostrum differently sculptured. Some specimens are maculate nearly as in *Oph. tuberosus*. The posterior cotyloid cavities are distinctly cavernous.

Occurs in Kansas and New Mexico.

E. argentatus Lec. (*Ophryastes*) Proc. Acad. vi, p. 444.

Form oblong, surface covered with pearly white scales, vertex convex. Rostrum with distinct basal impression, above trisulcate, median sulcus fine and long, lateral sulci deeper, shorter and arcuate ; surface sparsely punctured. Thorax broader than long, sides arcuate, base and apex truncate, median line distinct, surface deeply perforato-punctate. Elytra oval, slightly oblong, with broad shallow striæ with large closely placed punctures ; intervals slightly convex. Body beneath and legs silvery white. Length .60 inch ; 15 mm.

The cotyloid cavities of hind tibiæ are scarcely at all cavernous. This is the third species in size of the genus and may readily be known by the characters given in the table.

Occurs in the desert regions of south-eastern California.

E. lucanus, n. sp.

Form oblong, moderately robust. Head and rostrum as long as the thorax. Rostrum with distinct transverse impression at base, and with fine median line only, surface punctured covered with intermixed cinereous and fuscous scales. Thorax nearly spherical, truncate at apex and base, slightly wider than long, median line broad but shallow, surface coarsely punctured covered with cinereous and fuscous scales with a broad, darker line on each side. Elytra oval, slightly longer than twice the thorax, with rather broad but very shallow striæ with coarse distant punctures, intervals slightly convex, surface with dark cinereous scales irregularly marmorate with fuscous. Body beneath and legs covered with cinereous scales. Length .28 inch ; 7 mm.

The cotyloid cavities of the hind tibiæ are feebly cavernous and the oval space at tip is very narrow and glabrous.

One specimen from Cape San Lucas, Peninsula of California.

E. desertus, n. sp.

Form oblong, moderately robust, surface densely covered with silvery white scales. Rostrum with rather deep transverse impression at base, median sulcus shallow, indistinct, lateral sulci moderate, not deep, surface

Digitized by Google

sparsely punctured. Thorax slightly wider than long, narrower in front, sides feebly arcuate from apex to base, behind the apex a transverse impression moderately coarsely punctured, at sides near middle a feeble impression, median line finely impressed; disc very sparsely and comparatively finely punctured, at sides slightly rugulose and more coarsely punctured. Elytra oblong oval, three times as long as the thorax, one and a-half times as long as wide, striæ broad and shallow, punctures coarse and serrate, intervals feebly convex. Body beneath and legs densely covered with whitish scales. Length .88 inch; 22 mm.

Posterior cotyloid cavities strongly cavernous, tip of tibiæ truncate with broad oval scaly space. This species is the largest of the genus.

One specimen found dead at Carisa Creek on the borders of the Colorado Desert of California.

E. varius Lec. (*Ophryastes*) Proc. Acad. vi, p. 444.

Form oblong. Rostrum transversely impressed at base, median sulcus feeble, lateral sulci deep but short and arcuate, surface sparsely punctured covered with silvery white scales. Thorax cylindrical, sides moderately arcuate, apex and base truncate, median line finely impressed, disc coarsely and rather closely punctured, surface covered with silvery white scales with a median and lateral plumbeous stripe. Elytra oboval, broadest behind the middle, finely striate and with coarse punctures not closely placed, surface with silvery white scales irregularly marmorate with plumbeous spots sometimes forming two vittæ. Body beneath and legs silvery white. Length .30–.44 inch; 7.5–11 mm.

The cotyloid cavities of the hind tibiæ are moderately cavernous, the space at the tip very narrowly oval and scaly. This species in form and color resembles *decipiens*, but may be known by the form of the rostrum.

Occurs in the desert regions of California and Arizona.

E. geminatus, n. sp.

Form oblong oval, moderately robust. Rostrum transversely impressed at base, above trisulcate, median sulcus finely impressed, lateral sulci short but deep, surface sparsely punctured, covered with whitish scales, a plumbeous space in front of each eye. Thorax broadly oval, wider than long, widest at base, sides strongly arcuate, median line rather deeply impressed, disc coarsely punctured, surface densely clothed with whitish scales with a broad plumbeous stripe on each side. Elytra regularly oval, three times as long as thorax and a third longer than wide, finely striate, striæ obsoletely punctured, intervals flat, unequal; surface densely covered with white scales, striæ narrowly black, narrow intervals slightly darker in color than the others. Body beneath and legs white. Length .30–.50 inch; 7.5–12.5 mm.

The posterior cotyloid cavities are strongly cavernous and the tip of the tibiæ narrowly oval, the space scaly. A very distinct and striking species.

Not rare in Owen's Valley, California.

E. plumbeus, n. sp.

Oval moderately robust, surface densely covered with cinereous or plum-

Digitized by Google

beous scales. Head and rostrum as in *geminatus*, scales unicolorous. Thorax more than a-half broader than long, apex slightly narrower, sides strongly arcuate, disc coarsely but sparsely punctured surface with plumbeous scales, a darker vitta at the sides. Elytra broadly oval moderately inflated, finely striate, striæ indistinctly punctured, intervals equal, flat, surface densely covered with cinereous or plumbeous scales. Body beneath as above. Length .24–.36 inch ; 6–9 mm.

Cotyloid cavities of hind tibiæ moderately cavernous, tip of tibiæ with narrow oval scaly space. This species is of more robust facies than any other of the genus and may be known by the characters given in the table.

Not rare in Owen's Valley, California.

Group II. **Rhigopses.**

Rostrum quadrangular, broader in front, deeply sulcate above. Eyes narrow, acute beneath. Tarsi not dilated, beneath spinulose, third joint emarginate but not broader than the second. Corbels of hind tibiæ feebly cavernous. Posterior coxæ very widely distant. Intercoxal process broad, truncate, second abdominal segment much longer than the two following united, separated from the first by a strongly arcuate suture. Metasternal side pieces connate with the metasternum without evidence of sutures. Seventh joint of the funicle of the antennæ very close to the club.

The form and vestiture of the tarsi separate this group from the Strangaliodes and the structure of the abdomen from the Ophryastes. The rostrum and the scrobes are not unlike those of Ophryastes.

One genus occurs in our fauna.

RHIGOPSIS Lec.

Rhigopsis Lec. American Naturalist, 1874, p. 459.

Rostrum quadrangular, slightly longer than the head, dilated at tip and obliquely truncate above, upper surface deeply trisulcate, tip feebly emarginate. Mentum slightly retracted. Scrobes deep, well-defined, slightly arcuate in front, directed toward the lower border of the eye. Eyes narrow, acute beneath. Antennæ moderate, scaly, scape gradually stouter attaining the margin of the eye ; funicle 7-jointed, first two joints longer, stouter and nearly equal, 3–7 short, gradually broader, club oval, indistinctly articulated. Ocular lobes prominent. Scutellum indistinct. Elytra oval, feebly conjointly emarginate, humeri prominent, tuberculate. Metasternal side pieces connate with the body without suture. Hind coxæ very widely distant, intercoxal process broad, truncate. Second segment of abdomen longer than the two following united, separated from the first by a strongly arcuate suture. Tibiæ not mucronate at tip, corbels of hind tibiæ feebly cavernous. Tarsi spinous beneath third joint feebly emarginate, not wider than the preceding. Claws moderate, free. Body densely covered with scales, almost entirely obscured by exudation coating.

The tarsi of this genus although narrow are by no means of the *Byrsopide*

Digitized by Google

type and this character appears to be of minor importance in classification in the present tribe, as two other genera already mentioned have the third joint feebly emarginate and not wider than the third.

Rh. effracta Lec. Amer. Nat., 1874, p. 459.

Form oval, color piceous densely covered with cupreous scales almost entirely obscured by a dark brown exudation. Head and rostrum as long as the thorax. Rostrum above trisulcate, tip obliquely truncate, front slightly concave and with a hood-like tubercle over each eye. Thorax broader than long, sides at anterior third more rapidly narrowing, posterior two-thirds feebly converging to the base, surface tuberculate and very irregular. Elytra oval, disc slightly flattened, humeri slightly oblique and with moderately large tubercle, from which a ridge or costa arises forming the lateral margin; disc bicostate, the outer terminating in a tubercle at the sides of the declivity, intervals with large foveæ separated by smaller ridges uniting the costæ; tip of elytra with smaller tubercle on each side. Body beneath scaly obscured with exudation and with short scale-like hairs. Legs dark brown, sparsely scaly and with fine scale-like hairs. Length .20–.26; 5–6.5 mm.

The appearance of this insect is that of a miniature *Rhigus*, or of some *Leptops*. Its affinities appear to be rather with *Ophryastes* than with any other genus.

Occurs in California feeding on the Yucca.

Group III. Strangaliodes.

The group as made up in the following table is not precisely that intended by Lacordaire. There are without doubt several genera which should be placed in his *Eremnides*, but with the exception of *Phyxelis* I can find no genus presenting such marked differences in the form of the scrobes as to render it possible to draw the line with any degree of accuracy between those genera in which the scrobes are strictly lateral and those with the scrobes arcuate and directed inferiorly.

The arrangement of the genera in the following table exhibits a gradual transition in the form and length of the rostrum, from *Dichoxenus* which approaches most nearly *Ophryastes* in this respect as well as in the structure of the scrobes and abdomen, to *Phymatinus* with a long rostrum almost entirely lateral scrobes and normal abdomen. *Cimbocera* by its narrower tarsi and the structure of the antennæ approaches *Ophryastes* in another direction. *Melamomphus* resembles almost precisely *Amomphus* in form.

I have not been able to obtain any characters from the form of the corbels of the hind tibiæ, but have been compelled to group seven genera by a character almost as feeble, the presence or absence of mucro at the tip of the hind tibiæ. Our genera exhibit such a similarity of structure that it is almost impossible to define their limits and with the addition of new material generic definition will be reduced to a work of extreme difficulty.

Digitized by Google

The following table is the result of a study in which it has been my endeavor to develop a serial arrangement exhibiting,

First, a gradual transition in the form of the rostrum, from the more robust to the elongate.

Second, the tendency of the scrobes to change from the strongly arcuate to the nearly straight and shallow form.

Third, the structure of the abdomen, with the three segments nearly equal (as in *Ophryastes*), to those with the abdomen of normal structure.

First suture of abdomen straight; second segment rarely as long as, never longer than the two following united; hind tibiæ usually mutic.
- Scrobes deep, well defined, at least moderately arcuate, passing inferiorly.
  - Scrobes strongly arcuate, passing beneath at a distance from the eyes.................. **DICHOXENUS.**
  - Scrobes moderately arcuate, passing immediately beneath the eye................ **ANAMETIS.**
- Scrobes evanescent posteriorly, badly defined, nearly straight, directed toward the lower angle of the eye.
  - Metasternal side pieces rather wide, suture distinct.
    - Hind tibiæ distinctly mucronate; corbels cavernous........................... **MELAMOMPHUS.**
    - Hind tibiæ not mucronate; corbels open... **DYSLOBUS.**
  - Metasternal side pieces indistinct, suture obliterated.
    - Hind tibiæ not mucronate; corbels open.. **PANSCOPUS.**

First suture of abdomen arcuate; second segment as long as, and frequently longer than the two following united.
- Seventh joint of funicle distant from the club; third joint of tarsi broader than the second, tarsi densely pubescent beneath.
  - Hind tibiæ not mucronate.
    - Scrobes strongly arcuate, moderately deep; passing rapidly beneath at a distance from the eyes.
      - Support of deciduous piece of mandible not prominent.
        - Anterior tibiæ denticulate within; surface of body scaly without hairs; corbels of hind tibiæ open............. **ORIMODEMA.**
        - Anterior tibiæ not denticulate; surface scaly and hairy; corbels sub-cavernous............................ **MIMETES.**

Digitized by Google

Support of deciduous piece prominent; anterior tibiæ not denticulate. Surface scaly and with erect hairs.

Corbels of hind tibiæ cavernous; humeri entirely obliterated.......... **DIAMIMUS.**

Corbels of hind tibiæ open; humeri rectangular........................ **PERITAXIA.**

Scrobes very feebly arcuate, evanescent posteriorly, directed toward the lower angle of the eye, and short.............. **THRICOMIGUS.**

Hind tibiæ distinctly, usually rather strongly mucronate. Rostrum longer and narrower than the head and more or less auriculate.

Front convex separated from the rostrum by a transverse impression; side pieces of metasternum distinct, suture entire.. **AMNESIA.**

Front flat, rostrum continuous on the same plane and usually flattened above; side pieces of metasternum indistinct, suture in great part obliterated.

Body above finely tuberculate, scales large **PHYMATINUS.**

Body not tuberculate, scales small and denser................ .... **NOCHELES.**

Seventh joint of funicle contiguous to the club, third joint of tarsi feebly emarginate, scarcely broader than the preceding. Tarsi sparsely setose beneath.................... **CIMBOCERA.**

DICHOXENUS n.g.

Rostrum larger and slightly narrower than the head, slightly transversely impressed at base, feebly convex above, sub-quadrangular, alæ very feebly prominent, tip emarginate and with a small smooth space. Scrobes lateral deep, well defined, arcuate, passing rapidly beneath the head at a distance in front of the eyes. Antennæ moderate, sub-apical; scape gradually clavate, scaly, scarcely passing the anterior border of the eyes; funicle 7-jointed, joints 1–2 sub equal, the first stouter, 3–7 obconical gradually shorter, club elongate oval. Eyes oval, oblique. Thorax oval, broader than long, truncate at apex and base, ocular lobe broad and moderately prominent. Scutellum indistinct. Elytra oval, not wider at base than the thorax. Metasternal side pieces indistinct. Intercoxal process of abdomen broad, slightly arcuate in front. Second segment of abdomen shorter than the two following united, separated from the first by an absolutely straight suture. Anterior and middle tibiæ feebly mucronate, the former feebly denticulate within. Articular cavities (*corbels*) of hind tibiæ open. Tarsi normal, densely pubescent beneath. Claws moderate, free. Body scaly and with short erect setæ.

Digitized by Google

This genus should probably be referred to the group Leptopsides of Lacordaire by its rather quadrangular rostrum although the lateral grooves and carina are here entirely wanting. Whether the genus be placed in the above group or with the *Strangaliodides*, the form of the scrobes, the short scape and the rather short second segment with straight first suture characterize it as distinct from any genus there described.

D. setiger, n. sp.

Oblong oval, densely covered with moderately large, imbricated, cinereous scales, discolored brownish by an exudation, and with short erect setæ. Head and rostrum slightly longer than the thorax, densely covered with cinereous discolored scales, with erect slightly clavate setæ sparsely placed. Thorax oval, broader than long, slightly narrower in front, apex and base truncate, sides moderately arcuate, disc convex, rugulose, subgranulose at the sides, surface covered as the rostrum. Elytra oval, slightly attenuate at apex, base feebly emarginate, humeri obtuse, disc moderately convex, striate, striæ rather finely punctured, intervals slightly convex, densely scaly and with a single row of short erect setæ on each. Body beneath less densely clothed than above, scales slightly pearly, setæ very short and recumbent. Legs moderately densely scaly and sparsely setose.

Length .24 inch; 6 mm.

Occurs in Texas. Belfrage 747.

MELAMOMPHUS n. g.

Rostrum longer and narrower than the head, cylindrical at base, slightly broader at tip with the alæ moderately prominent, tip feebly emarginate and with a narrow smooth space. Mandibles moderately prominent, supports of deciduous pieces also slightly prominent. Mentum transversely oval, sub-mentum with short peduncle. Front convex, separated from rostrum by a slight sinuation. Scrobes short, slightly arcuate, moderately deep in front, rapidly evanescent posteriorly, directed slightly beneath the eye. Antennæ sub-terminal, moderate; scape gradually thicker to tip, passing slightly the middle of the eye, setose; funicle 7-jointed, joints 1–2 longer, the first longer than the second, 3–7 transverse, short, sub-perfoliate, and verticillate with moderately long setæ: club oval, pointed. Eyes transversely oval, pointed beneath. Thorax oval, broader than long, lobes moderate and with short fimbriæ. Scutellum small, triangular. Elytra oval, not wider at base than the thorax, feebly emarginate at base. Metasternum short, side pieces moderately wide, separated by an arcuate suture. Intercoxal process moderate. Second abdominal segment not longer than the two following united, first suture straight. Tibiæ mucronate, the anterior feebly denticulate within, articular surfaces of hind tibiæ cavernous. Tarsi normal. Body densely scaly and hairy.

M. niger, n. sp.

Form oblong oval, densely covered with brownish black scales and with moderately long black hairs. Head and rostrum longer than the thorax,

Digitized by Google

densely scaly and sparsely hairy. Thorax transversely oval, truncate at base and apex, sides regularly arcuate, disc convex, densely tuberculate, each tubercle punctured at summit, surface sparsely hairy. Elytra oblong oval and with rows of moderately large punctures deeply impressed, not closely placed, intervals flat, densely scaly, each with two rows of moderately long erect black hairs. Body beneath black, not scaly, coarsely and deeply punctured. Legs piceo-rufous or black, sparsely scaly and hairy. Length .32 inch; 8 mm.

Excepting its black color this species resembles very closely *Peritaxia hispida*, of the present tribe, in its general form and appearance, the generic characters are however very different.

Occurs in Nevada.

DYSLOBUS Lec.

Dyslobus (*pars*) Lec. Ann. Mag. Nat. Hist., 1869, p. 380.

Rostrum longer than the head and slightly narrower, slightly wider at base and apex than at middle, alæ very feebly divergent, base cylindrical, apex sub-quadrangular and feebly emarginate. Front convex separated from the rostrum by a feeble transverse impression. Scrobes deep in front, rapidly evanescent posteriorly, slightly arcuate and directed toward the middle of the eye. Eyes transverse oval, obtuse beneath. Antennæ moderate, scape feebly thicker to tip, attaining the hinder margin of the eye; funicle 7-jointed, first joint slightly longer, 2–7 obconical and gradually shorter; club elongate oval, pointed. Thorax oval, not wider than long, lobes broad but very short, fimbriate. Scutellum confined entirely to the peduncle. Elytra oblong oval, not wider than the thorax. Metasternum short, side pieces moderate, suture distinct. Intercoxal process quadrangular, arcuate at apex. Second segment shorter than the other two united, first suture very nearly straight. Anterior tibiæ mucronate, arcuate in both sexes, denticulate within, middle tibiæ straight, mucronate, hind tibiæ straight ♀ or suddenly arcuate near the tip and furnished with a brush of moderately long silken hairs ♂, not mucronate at tip. Articular cavities of hind tibiæ open. Tarsi normal. Body densely scaly and with very short hairs.

Having found it necessary to separate the species of *Dyslobus* to form two genera, I have chosen as the type the first species mentioned (*D. segnis*) especially as it is the only one in which the second abdominal segment is rather short, and the first suture straight. This genus must be placed near *Panscopus*, which it resembles somewhat in form but is rather more elongate.

D. segnis Lec. (*Otiorhynchus*) Pacif. R.R. Rep. App. I, p. 56, 1857

Form oblong, surface densely covered with pale brownish scales and very short hairs. Head and rostrum as long as the thorax, densely covered with brownish and cinereous scales. Thorax broadly oval, as wide as long and nearly as wide as the elytra at their widest part, apex and base truncate, sides regularly arcuate, disc feebly convex, densely covered with brownish

Digitized by Google

scales with paler spaces near the sides. Elytra oblong oval, twice as long as wide, sides feebly arcuate, apex feebly attenuate, posteriorly suddenly declivous and sub-compressed, disc feebly convex, striate, striæ with coarse rather distantly placed punctures, intervals flat densely scaly and with two irregular rows of very short setæ on each. Body beneath not densely covered with pearly white scales and with very short hairs. Legs moderately densely scaly, scales brown with whitish patches irregularly interspersed. Length .36–.44 inch ; 9–11 mm.

The sexual distinction is found in the rather sudden bending of the hind tibiæ of the male with a brush of moderately long silken hairs near the tip. Occurs in California and Oregon.

PANSCOPUS Sch.

Panscopus Schönh. Curc. vi, 2, p. 266.

Rostrum a little longer and narrower than the head, separated from the latter by a moderately strong arcuate depression, robust, rounded at base, tip rather strongly emarginate, above convex obtusely carinate. Front flat. Scrobes deep, well defined, rather strongly arcuate, directed toward but not attaining the lower angle of the eye. Antennæ moderate, scape clavate attaining the middle of the eyes ; funicle 7-jointed, 1–2 longer, the first longer than the second, joints 3–7 obconical, gradually broader, club oval acute. Eyes transversely oval, obtusely pointed beneath. Thorax broader than long, sides regularly arcuate, lobes short but broad. Scutellum nearly invisible. Elytra oblong oval, not wider than the thorax, truncate at base. Metasternum short, side pieces indistinct, suture obliterated. Intercoxal process moderate, truncate in front. Second abdominal segment equal to the two following, separated from the first by a straight suture. Anterior tibiæ feebly denticulate within. Articular surfaces of hind tibiæ open. Tarsi normal. Body oblong, surface densely scaly, and with short setæ.

P. erinaceus Say (*Barynotus*), Curc. N. A. p. 12 ; Am. Ent. 1, p. 272; Sch. loc. cit.

Form oblong moderately robust, surface densely covered with brownish scales, with paler spots irregularly placed on the elytra and a lateral stripe on the thorax. Head and rostrum slightly longer than the thorax, densely scaly, scales distinctly cupreous. Thorax slightly broader than long, apex and base truncate, sides regularly and rather strongly arcuate, disc moderately convex, median line distinctly impressed, surface rugulose, densely scaly, scales indistinctly cupreous, at the sides a paler line. Elytra oblong oval, striate, striæ with moderately large distant punctures, intervals feebly convex with a single row of short setæ and densely covered with brownish scales, sometimes with a slight cupreous lustre and with small paler spots irregularly placed especially numerous near the apex. Body beneath and legs similarly covered with scales. Length .24–.32 inch ; 6–8 mm.

Occurs from Canada to Pennsylvania.

The large majority of the specimens are uniformly covered with a brown-

Digitized by Google

ish coating the result of an exudation and adhering argillaceous material. The above description has been made from a clean specimen.

ANAMETIS n. g.

Rostrum longer and narrower than the head, moderately robust, slightly broader in front, tip feebly emarginate with a small smooth space, limited behind by an elevated line. Scrobes moderately deep, well defined, arcuate and directed beneath the lower angle of the eye. Antennæ moderate, anterior, scape gradually clavate, attaining the middle of the eye; funicle 7-jointed, 1–2 elongate, equal, 3–7 obconical, the seventh free; club elongate, oval. Eyes transversely oval, obtuse beneath. Thorax transversely cylindrical, narrower in front, base and apex truncate, lobes short, with slight fimbriæ. Scutellum small triangular. Elytra oval, emarginate at base and very slightly wider than the thorax. Metasternum short, side pieces indistinct, suture obliterated. Intercoxal process moderate, arcuate in front, second segment of abdomen as long as the the two following united, separated from the first by a straight suture. Anterior and middle tibiæ mucronate at tip, the former denticulate within, hind tibiæ extremely feebly or not mucronate, the articular surfaces sub-cavernous. Tarsi normal. Surface densely scaly and with short setæ.

As in all the genera in this vicinity the front is convex and the rostrum at base transversely impressed.

A. grisea, n. sp.

Form oval, surface densely and uniformly covered with cinereous scales and short setæ. Head and rostrum as long as the thorax, densely scaly, scales slightly pearly. Rostrum feebly convex along the middle, rarely with a finely impressed longitudinal line on each side. Thorax wider than long, slightly narrower in front, disc moderately convex, surface densely scaly and sparsely setose. Elytra regularly oval, striate, striæ moderately punctured, intervals slightly convex, densely scaly and irregularly biseriately setulose. Body beneath and legs with similar vestiture, but less dense. Length .20–.28 inch ; 5–7 mm.

This species resembles somewhat *Epicærus formidolosus* in form but is more elongate.

Occurs in Kansas, Dacota, Illinois and Georgia, and is common.

ORIMODEMA n. g.

Rostrum shorter but narrower than the head, cylindrical at base, sub-quadrangular at apex, with a transverse impression at some distance in front of the eyes, tip feebly emarginate, with narrow smooth space without elevated line. Supports of mandibular pieces not prominent. Scrobes deep, well defined, arcuate, passing rapidly inferiorly at a distance from the eyes. Antennæ moderate anterior, scape gradually clavate, scaly, attaining the middle of the eye; funicle 7-jointed, 1–2 large, equal, 3–7 obconical gradually shorter, seventh not broader and free; club oval, acute. Eyes transversely oval, pointed beneath. Thorax cylindrical, truncate at apex

Digitized by Google

and base, sides very feebly arcuate, lobes prominent and fimbriate. Scutellum short transverse. Elytra elongate oval, gradually attenuate posteriorly. Metasternum short, side pieces indistinct, suture obliterated. Intercoxal process moderate arcuate in front, second abdominal segment longer than the two following united, separated from the first by a suture strongly arcuate at middle. Anterior and middle tibiæ mucronate at tip, the former denticulate within. Articular surface of hind tibiæ open, the tibiæ not mucronate at tip. Tarsi normal, surface densely scaly and not pilose.

This genus appears from description to be allied to *Dasydema* and *Orimus*. The femora are sub-pedunculate, the anterior stouter. The scutellum is distinct, the rostrum short and stout, and the surface scaly without setæ. In these particulars it differs from one or other of these two genera, and agrees with them in having the corbels open.

O. protracta, n. sp.

Form elongate oval, surface densely covered with brownish scales with slight cupreous lustre, elytra irregularly variegated with paler patches. Head and rostrum as long as the thorax, densely scaly, scales brownish and paler intermixed. Head large. Thorax cylindrical, base and apex truncate, equal, not wider than long, sides feebly arcuate, disc regularly convex, surface densely covered with pale-brownish scales. Elytra elongate oval, regularly attenuate behind, base not wider than the thorax, humeri obliquely rounded, sides feebly arcuate, disc feebly convex, feebly striate, striæ with moderate, not closely placed punctures, intervals flat, densely covered with pale-brownish scales with distinct cupreous lustre, and with paler spaces irregularly placed. Under surface moderately densely scaly, scales paler than above. Tibiæ sparsely fimbriate. Length .36 inch; 9 mm.

Occurs in Colorado and New Mexico.

MIMETES Sch.

Mimetes Schönh. Mant. sec. Curc. p. 23.

Rostrum slightly longer and narrower than the head, sub-quadrangular, slightly dilated and feebly emarginate at tip, separated from the front by a distinct, arcuate impression. Sub-mentum with a distinct peduncle, not inflexed. Scrobes deep, well defined, rather suddenly arcuate and passing near the lower border of the eye. Eyes round, coarsely granulated, feebly prominent. Antennæ moderately long; scape gradually clavate, attaining nearly the middle of the eye; funicle 7-jointed, 1–2 longer, the first longer than the second, 5–7 obconical, gradually shorter; club oval, pointed. Thorax cylindrical, sides feebly arcuate, apex slightly narrower and with the base truncate. Scutellum small triangular. Elytra oblong oval, slightly acuminate posteriorly, base not wider than the thorax and broadly emarginate, humeri rounded. Metasternum moderate, side pieces narrow, suture distinct in its entire length. Intercoxal process broad, rounded in front; second segment of abdomen much longer than the two following united, separated from the first by very strongly arcuate suture. Tibiæ (except

Digitized by Google

posterior) distinctly but feebly mucronate. Articular surfaces of hind tibiæ distinctly cavernous. Claws moderate, free.

It is not without doubt that I consider the genus before me identical with *Mimetes*. The thorax is provided, in well preserved specimens with the post-ocular thoracic fimbriæ characteristic of the *Tanymecides* of Lacordaire. These hairs are however very easily removable, and it is possible that Lacordaire may have had a specimen before him similar to one now at hand. The present species has been submitted to Mr. H. Jekel, who agrees with me in placing it near *Amomphus* and its allies. The mandibles have no prominent support for the deciduous piece. In addition to the characters given in the table, this genus has a much less robust rostrum and the frontal impression is between the eyes and not at a distance in front as in *Orimodema*.

M. setulosus Lac. Gen. Curc. vi, p. 40.

Form oblong oval, surface densely covered with cinereous scales, variegated in some specimens with white and pale cupreous. Head and rostrum longer than the thorax, densely punctured and scaly. Antennæ rufous, sparsely pubescent. Thorax, cylindrico-oval, slightly narrower and feebly constricted in front, sides moderately arcuate, base truncate, disc feebly convex, densely punctured and densely covered with cinereous scales. Elytra oblong oval, nearly twice as long as wide, sides moderately arcuate and feebly attenuate behind, base broadly emarginate ; disc feebly convex, finely striate, striæ not closely punctured, intervals at sides feebly convex and at apex slightly alternating, surface densely scaly, on each interval a row of short, distant, semi-erect setæ. Body beneath densely scaly and very sparsely hairy. Legs moderately densely scaly, tibiæ more distinctly pilose especially on the inner side. Length .22 inch ; 5.5 mm.

Occurs at San Diego and San Buenaventura, California.

M. seniculus, n. sp.

Form elongate oval, surface densely covered with intermixed and pale-brown scales very densely placed. Head and rostrum as long as the thorax, densely scaly and with fine short whitish hairs. Rostrum with feeble median impression in front and an angulate impression at base between the eyes. Thorax oval, longer than wide, sides moderately arcuate, a slight constriction at the sides behind the anterior margin, apex and base truncate, disc feebly convex densely scaly, scales pale-brownish, a whitish median line. Elytra oblong oval nearly twice as long as the thorax, and one-half wider at middle, moderately convex, densely scaly, scales pale-brown and cinereous irregularly clouded, surface faintly striate, striæ feebly punctured, intervals flat, with a single row of short whitish hairs. Body beneath similarly scaly, scales decidedly pearly and with more evident hairs, especially at the middle of the posterior portion of the first ventral segment ♂. Legs pale-brownish, similarly but more sparsely scaly Length .14 inch ; 3.5 mm.

One specimen California (Motschulsky) differs from the preceding species by its smaller size, more slender form and flat elytral interstices.

Digitized by Google

This species was sent by Motschulsky as *Sitones seniculus*, Mann., to Dr. LeConte; another type from the same source sent to Allard proved to belong to another entirely different species, of which mention will be made by Dr. LeConte in the proper place.

The original description by Mannerheim is here appended, so that a comparison of descriptions may be readily made.

"Oblongus, subcylindricus, niger *cinereo-tomentosus* et setosus, fronte canaliculata, rostro excavato, thoraci *profunde rugose punctato*, lateribus vix rotundato, *elytris profunde punctato-striatis*, antennarum basi, tibiisque ferrugineis. Long. 1⅔ lin; latit. ½ lin.

DIAMIMUS n. g.

Rostrum longer and narrower than the head, slightly broader in front, cylindrical at base, separated from the head by a transverse impression, tip feebly emarginate and with very small smooth space. Scrobes deep, well defined arcuate, directed beneath at a distance from the eyes. Antennæ moderate, scape feebly clavate, attaining the middle of the eye; funicle 7-jointed, 1–2 larger, 3–7 obconical, gradually decreasing in length, the last distant from the club which is elongate oval, acute. Eyes broadly oval. Thorax cylindrical, sides feebly arcuate, lobes very short, fimbriate. Scutellum distinct. Elytral oblong oval, humeri obliterated. Metasternum short, side pieces indistinct suture obliterated. Intercoxal process moderate, truncate in front. Second segment longer than the two following, separated from the first by an arcuate suture. Anterior and middle tibiæ mucronate at tip, not denticulate within, hind tibiæ not mucronate, their corbels cavernous. Tarsi normal. Body oblong densely scaly, sparsely pilose.

D. subsericeus, n. sp.

Form oblong, surface moderately densely covered with cinereous scales slightly cupreous and with micaceous lustre and with erect hairs sparsely placed. Head and rostrum not longer than the thorax, moderately densely scaly, sparsely pilose. Thorax cylindrical, slightly wider than long, apex and base truncate, sides regularly and moderately arcuate, disc moderately convex, sparsely punctured, moderately densely scaly and sparsely pilose. Elytra oblong oval, sides feebly arcuate, humeri obsolete, surface moderately convex and with rows of moderate, not closely placed punctures, intervals flat, moderately densely scaly, each with a row of moderately long erect hairs. Body beheath less densely scaly and with very few hairs. Legs sparsely scaly, hairs longer. Surface color less the vestiture piceous. Length .18–.22 inch; 4.5–5.5 mm.

Occurs in New Mexico and Colorado.

PERITAXIA n. g.

This genus differs from the preceding by the following characters:

Scrobes more evanescent posterioriy, less arcuate and directed more inferiorly. Corbels of hind tibiæ open. Humeri rectangular.

Digitized by Google

In their form of vestiture the two genera agree. In both the supports of the mandibular pieces are moderately prominent and obliquely truncate at tip.

Amomphus (*Cottyi*) is also closely allied and differs especially in the wide metasternal side pieces with the suture distinct.

Two species occur in our fauna.

Ocular lobes distinct but feeble, surface covered with very dark piceous scales and short cinereous hair..........	**rugicollis.**
Ocular lobes wanting but replaced by a decided fringe of stiff hairs, surface with cinereous scales and longer greyish hair..........	**hispida.**

P. rugicollis, n. sp.

Form oblong, color piceous, surface sparsely covered with inconspicuous scales, not differing in color from that of the surface, and with short brownish hairs. Head and rostrum slightly longer than the thorax, sparsely scaly and with few hairs. Thorax transversely oval, apex and base truncate, sides moderately arcuate, disc moderately convex, granulato-rugulose, median line obsoletely impressed, surface sparsely scaly and pilose. Elytra oblong oval, base feebly emarginate, humeri sub-rectangular, disc moderately convex, feebly striate and with coarse punctures moderately closely placed, intervals flat, sparcely scaly, bi-seriately pilose. Body beneath and legs indistinctly scaly and with short greyish hairs. Length .30 inch; 7.5 mm.

Occurs in Colorado and New Mexico.

This species bears considerable resemblance superficially to *Melamomphus niger* of the present tribe.

P. hispida, n. sp.

Oblong oval, piceous, surface scaly and hispid. Head and rostrum as long as the thorax, moderately densely punctured, not densely scaly and with numerous, moderately long, erect, yellowish hairs. Thorax oval, slightly narrower in front, as broad as long, sides moderately, base feebly arcuate, disc moderately convex, surface densely and rather coarsely punctured and rugulose, moderately densely scaly and hairy. Elytra oblong oval, nearly three times as long as the thorax, moderately convex, surface deeply striate, striæ with large but not closely placed punctures, intervals flat, finely punctured, sparsely scaly and hairy. Body beneath piceous, sparsely scaly and with shorter hairs than the upper surface. Legs piceous, sparsely scaly and hairy, the tibiæ with longer hairs. Length .36 inch; 9 mm.

The scales covering the surface rather sparsely are of a dirty-white color with a slight tinge of cupreous. In form this insect resembles *Amomphus Cottyi* but with the sides of thorax and elytra more arcuate.

Occurs abundantly in Colorado.

Digitized by Google

THRICOMIGUS n. g.

Rostrum slightly longer and narrower than the head, feebly arcuate, very slightly dilated at tip, base cylindrical and with transverse impression, tip very feebly emarginate. Scrobes moderately deep in front, rapidly evanescent posteriorly, very feebly arcuate and directed toward the lower portion of the eye. Antennæ moderate, scape gradually clavate, slightly passing the middle of the eye; funicle 7-jointed, joints 1–2 longer, the first longer than second, 3-7 moniliform; club oval, pointed. Eyes broadly oval. Thorax oval, slightly broader than long, apex and base truncate, sides moderately arcuate, lobes very short, fimbriate. Scutellum short, broad. Elytra regularly oval. Metasternum short, side pieces moderate, suture distinct. Intercoxal process moderate, truncate in front, second segment longer than the two following united, suture distinctly arcuate. Anterior tibiæ denticulate within, this and the middle tibiæ mucronate at tip. Articular surfaces of hind tibiæ sub-cavernous, tip not mucronate. Tarsi normal. Body above densely scaly and pilose.

The unique species composing this genus resembles a large *Phyxelis glomerosus* but is relatively more elongate. The alæ of the rostrum are slightly prominent, and the scrobes are rather better visible from above than beneath, but are not superior as in *Phyxelis*, and do not differ notably from those of the genera placed by Lacordaire in the present tribe.

T. luteus, n. sp.

Form oval, surface densely covered with pale ochreous scales, in some specimens slightly cupreous, and with short erect hairs. Head and rostrum as long as the thorax, moderately densely scaly, scales at the sides paler, and with erect, short, brownish hairs sparsely placed. Thorax slightly broader than long, slightly narrower at apex, sides moderately and regularly arcuate, apex and base truncate, disc moderately convex, densely scaly, sparsely hairy. Elytra oval, humeri broadly rounded, disc moderately convex, striate, striæ with moderate, not densely placed punctures, intervals flat densely scaly, scales paler at the sides, each interval with two rather irregular rows of erect, brownish, short setæ. Body beneath less densely scaly than above. Legs sparsely scaly and with longer hairs than the body. Length .28–.30 inch; 7–7.5 mm.

Occurs in Bitter Root Valley and in Colorado.

AMNESIA n. g.

Rostrum slightly longer and narrower than the head, cylindrical at base and with transverse impression, apex slightly broader, alæ very feebly prominent, tip feebly emarginate. Scrobes moderately deep and well defined anteriorly, feebly arcuate, rapidly evanescent and feebly limited posteriorly, directed toward the lower portion of the eye. Antennæ moderate, sub-apical, scape gradually clavate, attaining the middle or posterior border of the eye, funicle 7-jointed, first two longer and sub-equal, 3–7 shorter, usually obconical, sometimes longitudinally ovate, club oval,

Digitized by Google

pointed. Thorax oval, usually broader than long, sides moderately arcuate, apex and base truncate, lobes very short and slightly fimbriate. Scutellum small, scarcely entering between the elytra. Elytra oval or oblong oval, base not broader than the thorax, feebly emarginate, humeri feebly rectangular or entirely obliterated. Metasternum short, side pieces moderately wide, suture distinct in its entire length. Intercoxal process moderate truncate in front. Tibiæ mucronate at tip, articular surfaces of hind tibiæ feebly cavernous. Tarsi normal. Body above densely scaly and with extremely short black setæ in some species, and moderately long hairs in others.

This genus is a part of that included by Dr. Leconte in *Dyslobus*, the generic description of which appears to have been made from *D. segnis* and *A. granicollis* of the present genus. I have retained the name *Dyslobus* for the species with the first abdominal suture straight as this character is the most important and striking in the description. Regarding the position the genus should occupy in the groups indicated by Lacordaire, I am in some doubt. The scrobes are lateral, feebly arcuate and directed toward the lower front of the eye. They do not become rapidly inferior as in several genera already noted, and are but slightly less arcuate and less defined than in *Panscopus*.

For the present, I prefer to retain *Amnesia* in the present group as one of the leads toward the *Phytoscaphi* to which the next genus probably belongs, *Nocheles* in turn being a lead toward the *Eremnini*.

I consider (*Dyslobus*) granicollis Lec. the type of the genus.

The following table will make our species easily known :

Hairs of the surface, especially on the elytra, very short and inconspicuous. Humeri rectangular, anterior tibiæ moderately denticulate.

Body beneath rather sparsely and not coarsely punctured........ **granicollis.**

Body beneath with coarse deep punctures, denser on the intercoxal process and last ventral segment........ **decorata.**

Hairs of surface very distinct, usually rather long.

Humeri rectangular, anterior tibiæ moderately denticulate.

Surface of thorax even, not granulate........ **ursina.**

Surface of thorax granulate, each granule punctured........ **rauca.**

Humeri obliterated, anterior tibiæ feebly denticulate, surface of thorax with punctured granules.

Elytra oval, wider at middle than the thorax, and not twice as long as wide.

Thorax not narrowed in front, granules inconspicuous, surface densely scaly ; elytra with cinereous scales........ **alternata.**

Digitized by Google

Thorax not narrowed in front, granules of moderate size and not very approximate, surface sparsely scaly; elytra with brownish scales.. **sordida.**

Thorax distinctly narrowed in front, granules small and very indistinct, surface sparsely scaly; elytra with brownish scales............. **decidua.**

Elytra oblong, not or scarcely wider at middle than the thorax, and twice as long as wide .... **elongata.**

A. granicollis Lec. (*Dyslobus*) Ann. Mag. Nat. Hist. 1869, p. 380.

Form oval, above moderately densely covered with pale-brownish scales, variegated with paler and darker spots, and with extremely short and inconspicuous black setæ. Head and rostrum as long as the thorax, moderately densely punctured, scales cupreous, rostrum with a feeble carina terminating in a slight frontal puncture. Thorax slightly broader than long, apex and base truncate and nearly equal, sides moderately arcuate, lobes very feeble, disc moderately convex, indistinctly granulate, granules punctured at summit, surface moderately densely scaly and with very short setæ, scales pale-brownish with slight cupreous lustre, paler at the sides. Elytra oval, conjointly emarginate at base, humeri rectangular, disc moderately convex, apex rather suddenly declivous, indistinctly striate, striæ with moderately large, not closely placed punctures, intervals alternately more convex especially toward the declivity, surface densely scaly, scales pale-brownish, variegated with darker and paler spots, especially on the more convex intervals, each interval with numerous short, black setæ, very inconspicuous. Body beneath very sparsely scaly at the sides, and with scale-like hairs at middle, surface rather sparsely punctured. Legs sparsely scaly and with short hairs. Length .38-.40 inch; 9.5–10 mm.

Occurs in Vancouver and Oregon.

This species has somewhat the facies of *Tyloderes chrysops*.

A. decorata Lec. (*Dyslobus*) Ann. Mag. Nat. Hist. 1869, p. 381.

Form oblong oval, surface densely covered with cinereous scales, variegated with brownish and cupreous spaces. Head and rostrum nearly as long as the thorax, surface rather coarsely punctured, moderately densely scaly, scales cupreous; rostrum above feebly subcarinate. Thorax oval, slightly broader than long, apex and base truncate, the apex slightly narrower, sides rather strongly arcuate especially at posterior third, lobes very feeble; disc very feebly convex, sub-rugosely punctate and feebly granulate, sparsely scaly, scales silvery and cupreous and with extremely short inconspicuous setæ. Elytra oblong oval, conjointly emarginate at base, humeri rectangular, sides moderately arcuate, disc moderately convex, apex rather suddenly declivous, surface striate, striæ with moderate, rather closely placed punctures, intervals slightly convex, and alternately slightly more convex near the declivity, densely scaly, scales cinereous or pale-brownish, variegated with cupreous and darker scales. Body beneath

Digitized by Google

piceous, with sparsely placed scale-like hairs, intercoxal process and last ventral segment densely cribrate punctate. Legs sparsely scaly and pubescent. Length .26 inch; 6.5 mm.

Although very different in appearance from the preceding species, there is some difficulty in finding characters expressible in words to separate the two. The thorax of the present species is relatively much broader and at its widest part but little narrower than the elytra. The alternation of elevation of the intervals is very little marked on the disc and is but slightly more evident near the declivity.

A variety ? occurs in Oregon with intervals nearly flat and similar.

Occurs in Oregon and Vancouver.

A. ursina, n. sp.

Form oblong oval, surface densely covered with brownish scales and with rather long, pale-brown erect hairs. Head and rostrum as long as the thorax, rostrum not subcarinate above, surface punctured, densely covered with brownish scales becoming cinereous at the sides and beneath and with moderately long erect hairs. Thorax not wider than long, apex and base equal and truncate, sides evenly arcuate, lobes very short; disc moderately convex, not granulate, finely punctured, densely covered with brownish scales with slightly pearly lustre, and paler at the sides and with long erect hairs. Elytra oval, very slightly wider at middle than the thorax, base feebly conjointly emarginate, humeri rectangular, sides moderately arcuate, apex gradually declivous, disc moderately convex, striate, striæ with rather coarse punctures closely placed, intervals slightly convex, densely covered with brownish scales and with two rows of closely placed and rather long, pale brownish hairs. Body beneath and legs sparsely scaly, scales slightly silvery, and with moderately long hairs. Abdomen sparsely punctured. Length .28 inch; 7 mm.

One specimen ♂, Oregon.

A. rauca, n. sp.

Oblong, surface densely covered with brownish scales, and with moderately long, pale-brownish hairs. Head and rostrum as long as the thorax, densely cribrate punctate, rostrum sub-carinate, surface sparsely scaly and hairy. Thorax nearly globose, slightly wider than long, apex truncate, base slightly arcuate, sides strongly arcuate, lobes very feeble, disc convex, moderately densely granulate, granules punctured at summit, surface sparsely scaly and hairy. Elytra oblong, scarcely wider at middle than the thorax, base feebly emarginate, humeri rectangular, disc moderately convex, obsoletely broadly striate, striæ with large, deeply impressed, rather closely placed punctures, intervals flat, densely covered with brownish scales and moderate hairs placed in two rows on each interval. Body beneath densely and coarsely punctured and with very few short hairs Legs sparsely scaly and hairy, hairs longer than on the body. Length .22 inch; 5.5 mm.

Differs from the preceding in sculpture and by the much shorter hairs of the upper surface.

Two specimens, San Francisco, Cal.

Digitized by Google

A. alternata, n. sp.

Oblong oval, surface densely covered with brownish cinereous hairs, the alternate intervals of the elytra paler. Head and rostrum as long as the thorax, sparsely punctured and with erect yellowish hairs, surface densely covered with cinereous scales, brownish at the sides; rostrum with a short median impression between the insertions of the antennæ. Thorax cylindrical, very slightly broader than long, sides moderately arcuate, surface densely covered with cinereous scales, slightly clouded at middle, with few erect hairs; when deprived of scales the surface consists of flattened punctured granules, moderately densely placed. Elytra oblong oval, one-third longer than wide, humeri obtusely rounded, surface striate, striæ with punctures of moderate size, not closely placed, intervals flat, densely covered with cinereous scales, each alternate interval darker at basal half and irregularly clouded near the apex, each interval with two very irregular rows of erect hairs. Body beneath not very densely covered with cinereous scales and with few hairs. Legs with densely placed scales and sparsely placed hairs longer than those of the surface. Length .26 inch; 6.5 mm.

This species from its densely scaly surface has a greater superficial resemblance with *decorata* than the species near which it is placed, but from its having rather conspicuous erect hairs on the entire upper surface it must be placed here.

Two specimens, Montana.

A. sordida, n. sp.

Form oblong oval, resembling *granicollis*, surface densely covered with brownish scales, indistinctly variegated with brownish spots and with rather short hairs. Head and rostrum as long as the thorax, moderately densely and coarsely punctured, rostrum distinctly sub-carinate above, surface very sparsely scaly and hairy. Thorax nearly spherical with apex and base truncate, lobes extremely short, disc moderately convex, finely and not closely granulate, each granule punctured at summit, surface sparsely scaly and hairy. Elytra regularly oval, one-half broader at middle than the thorax, base feebly emarginate, humeri entirely obliterated, disc moderately convex, finely striate, striæ with elongate punctures, intervals flat, densely scaly and with two rows of pale-brownish hairs of moderate length. Body beneath moderately densely punctured, sparsely hairy. Legs with very few scales, sparsely hairy. Length .34 inch; 8.5 mm.

The form of this species is very nearly that of *granicollis*, but with flat elytral intervals and without rectangular humeri.

One specimen, California (or Oregon).

A. decidua, n. sp.

Form oblong, surface moderately covered with pale-brownish, easily removeable scales and with brownish erect hairs. Head and rostrum slightly longer than the thorax, densely and coarsely punctured, sparsely scaly and hairy, scales at sides and tip cupreous, rostrum above, carinate. Thorax

Digitized by Google

oval, wider than long, slightly narrower at apex than base, sides moderately arcuate, lobes feeble, apex at base truncate, disc moderately convex, granulato-rugulose, very sparsely scaly and hairy. Elytra elongate oval, sides very feebly arcuate, base feebly emarginate, humeri entirely obliterated, disc moderately convex, obsoletely striate, and with moderately coarse closely placed punctures, intervals slightly convex, moderately densely covered with easily removable scales, and two rows of irregularly placed erect brownish hairs. Body beneath moderately densely punctured, with few elongate cupreous scales and sparsely hairy. Legs sparsely scaly and hairy, hairs longer on the tibiæ and denser near the tip. Length .34 inch; 8.5 mm.

Two specimens, Sauzalito, California.

A. elongata, n. sp.

Form rather slender, elongate, surface densely covered with brownish scales and hirsute. Head and rostrum slightly longer than the thorax, densely and coarsely punctured, sparsely scaly and hairy, rostrum above very feebly sub-carinate near the base. Thorax slightly broader than long, apex and base truncate, sides rather strongly arcuate, disc moderately convex, densely granulato-rugulose, sparsely scaly and hairy. Elytra scarcely longer at middle than the thorax, form oblong, base feebly emarginate, humeri entirely obliterated, disc moderately convex, feebly striate, striæ with elongate punctures, intervals nearly flat, moderately densely scaly, and with two rows of erect brownish hairs. Body beneath coarsely and densely cribrate punctate, surface sparsely hairy. Legs sparsely scaly and hairy. Length .26–.32 inch; 6.5–8 mm.

This species is easily known by its elongate form.

Two specimens, California.

PHYMATINUS Lec.

Phymatinus Lec. Ann. Mag. Nat. Hist., 1869, p. 382.

Rostrum oblique, longer and somewhat narrower than the head not separated from the head by a transverse impression, cylindrical at base, dilated at apex, alæ moderately prominent, tip not emarginate. Scrobes deep in front, nearly straight, very rapidly evanescent posteriorly and badly defined, directed toward the lower margin of the eye. Antennæ long, scape rather slender, feebly thicker to tip, passing slightly the middle of the eye. funicle 7-jointed, somewhat longer than the scape, joints 1-2 longer and equal, 3–7 obconical, gradually shorter, club oval, pointed. Eyes broadly oval, feebly prominent. Thorax cylindrical, apex and base truncate, sides more arcuate in front of middle, lobes feeble. Scutellum very indistinct. Elytra oval, very suddenly declivous and slightly inflexed posteriorly, base conjointly emarginate, humeri obtuse. Metasternum short, side pieces indistinct, suture entirely obliterated. Intercoxal process broad, truncate, second segment longer than the two following united, first suture strongly arcuate at middle. Tibiæ mucronate at tip, the anterior feebly denticulate

Digitized by Google

within, articular surface of hind tibiæ cavernous, tarsi normal, (third joint broadly bilobed) densely pubescent beneath. Surface densely scaly and with small granules.

This genus, as suggested by Dr. LeConte, should probably be referred to Lacordaire's group *Phytoscaphides*, but if so, I feel entirely unwilling to separate that group from the present, the scrobes of the genera here included showing a very gradual transition in form.

P. gemmatus Lec. (*Tyloderes*) Pacif. R.R. Rep. App. i, p. 56.

Elongate oval, black, surface densely covered with cinereous scales, with cupreous and pearly lustre at the sides, disc of thorax and elytra slightly brownish. Head and rostrum longer than the thorax, punctured and moderately densely scaly, sparsely setulose, rostrum with finely elevated median line terminating in a slight impression. Scape with scale-like hairs. Thorax cylindrical, as broad as long, apex and base truncate, sides arcuate, more strongly in front of middle, disc moderately convex and with median sulcus, surface with moderately large granules, each punctured and with a short stout seta, median line and narrow space each side not granulate, intergranular spaces densely scaly, scales darker on the disc, pearly and cupreous at the sides. Elytra regularly oval, very suddenly declivous posteriorly, sutural region more prominent at declivity, disc feebly convex, striæ obsolete, and with rows of indistinct punctures, each alternate interval with two indistinct rows of moderate granules, each punctured and bearing a short, stout, curved, black seta, interspaces densely scaly, scales darker on the disc, pearly and cupreous at the sides. Body beneath and legs moderately densely scaly, sparsely setulose, scales pearly and cupreous. Length .32–.40 inch ; 8–10 mm.

This species has a marked resemblance to *Tyloderes chrysops* in size, sculpture and general aspect.

Occurs in California and Oregon.

NOCHELES n. g.

Nocheles Lec. mss. Amer. Nat. 1874, p. 453, without characters.

Rostrum oblique, longer and narrower than the head, without transverse basal impression, above flattened, base quadrangular, apex dilated, alæ moderately prominent, tip feebly emarginate and with small smooth space. Scrobes very feebly arcuate, deep in front, very rapidly evanescent posteriorly, directed toward the lower margin of the eye. Antennæ moderate, scape very slightly passing the anterior margin of the eye, feebly stouter at tip ; funicle 7-jointed, joints 1–2 longer and equal, 3–7 gradually shorter, obconical ; club oval. Eyes oval. Thorax oval, broader than long, apex and base truncate, lobes moderate. Scutellum very small. Elytra oval, base very feebly emarginate, apex declivous. Metasternum short, side pieces indistinct, sutures entirely obliterated, intercoxal process moderate, truncate, second segment as long as the two following united, first suture arcuate. Tibiæ mucronate at tip, articular surfaces of hind tibiæ cavernous, tarsi normal. Surface densely scaly and with very short setæ.

Digitized by Google

Two species compose this genus.

Intervals of elytra convex, alternately more elevated; humeri not prominent.................................. **torpidus.**
Intervals convex, equal; humeri obtusely prominent........ **cinereus.**

N. torpidus Lec. (*Hylobius*) Pacif. R.R. Rep. App. 1, p. 55.

Elongate oval, surface densely covered with cinereous scales and with very short sub-erect setæ. Head and rostrum longer than the thorax, sparsely punctured, densely pubescent, and with very few short sub-erect scale-like hairs. Rostrum flat above, tip with small triangular smooth space, a fine median line near the tip. Thorax slightly broader than long, sides in front rather strongly arcuate, then gradually narrowed to base, disc moderately convex with a rather broad median channel deeper in front, surface sub-granular and very densely scaly and with few sub-erect scale-like hairs. Elytra oblong oval, slightly wider at base than the thorax, humeri rounded, disc moderately convex, feebly striate, striæ with moderate, rather closely placed, round punctures, each filled with a large scale, intervals convex, the sutural 2–4–6–8 more elevated, surface densely scaly, each interval with one row of short scale-like sub-erect hairs. Body beneath and legs very densely covered with scales similar to those of the upper surface. Length .26–.28 inch; 6.5–7 mm.

Old specimens of this species are frequently brownish. One female in the cabinet of Dr. LeConte has one of the short abdominal segments absent.

Not rare in Oregon.

N. æqualis, n. sp.

Form oblong oval, surface densely covered with cinereous scales, and with short erect setæ. Head and rostrum slightly longer than the thorax, densely scaly, sparsely setose. Rostrum slightly rounded above, at tip with very small smooth space and without median line. Thorax slightly broader than long, sides, moderately arcuate, disc feebly convex, median line feebly impressed, surface granulato-rugulose, moderately densely scaly and sparsely setose. Elytra oval slightly broader than the thorax, humeri obtusely prominent, disc moderately convex, feebly striate, striæ with distant punctures, intervals slightly convex, with a single row of setæ on each, surface densely covered with cinereous scales. Body beneath and legs densely scaly, sparsely setulose. Length .24–.26 inch; 6–6.5 mm.

A specimen of this species was sent to Lacordaire, who pronounced it a *Phyxelis*. This view I cannot accept as the scrobes are not superior as in that genus and the front is not transversely impressed. It is one of those forms (with the preceding species) which renders it extremely difficult at times to divide large masses of species into groups higher than genera.

Occurs from Kansas to British Columbia.

CIMBOCERA n. g.

Rostrum somewhat narrower and slightly longer than the head, parallel and sub-cylindrical at base, slightly dilated in front, tip sinuate, at base

Digitized by Google

with very slight transverse impression, front slightly more convex, alæ moderately prominent. Scrobes moderately deep, short, arcuate and directed rather rapidly inferiorly. Antennæ moderate, sub-apical, scape clavate, passing slightly the anterior margin of the eye; funicle 7-jointed, joints 1–2 longer, the first longer than the second, 3–7 short, broader than long, the last very close to the club and broader; club oval. Eyes oval, slightly pointed beneath. Thorax cylindrical, broader than long, apex and base truncate, sides moderately arcuate, lobes feeble, distinctly fimbriate. Scutellum invisible. Elytra regularly oval. Humeri rounded. Metasternum short, side pieces narrow, suture distinct. Intercoxal process moderate, arcuate in front; second segment of abdomen as long as the two following united, first suture strongly arcuate at middle. Anterior tibiæ alone mucronate, articular surfaces of hind tibiæ feebly cavernous. Tarsi setose beneath, third joint not broader than the second and very feebly emarginate. Claws free. Surface scaly and hairy.

The unique species on which the above genus is founded, resembles in general aspect certain elongate males of *Trigonoscuta pilosa*. The genus by the form of its tarsi and the seventh joint of funicle, approaches *Eupagoderes* of the group *Ophryastes*, differing however in the structure of the abdomen and metasternal side pieces.

C. pauper, n. sp.

Oblong oval, piceous, densely covered with pale brownish scales sparsely variegated with cinereous and with erect hairs. Head and rostrum as long as the thorax, moderately densely covered with pale brownish and cinereous scales intermixed and sparsely hairy, rostrum feebly canaliculate. Thorax cylindrical, slightly broader than long, apex and base truncate, sides moderately arcuate, disc convex, densely scaly and sparsely hairy. Elytra oval, finely striate, striæ indistinctly punctured except at the sides, intervals flat, densely scaly, each with two rows of moderately long yellowish hairs. Body beneath and legs much less densely scaly than above, sparsely hirsute. Length .24 inch; 6 mm.

This species is of the form and size of *Peritelus griseus* of Europe, and resembles it somewhat in vestiture.

One specimen, Dacota.

Group IV. Phyxeles.

Rostrum slightly narrower than the head, alæ not prominent. Scrobes superior, badly defined, feebly arcuate, rapidly evanescent posteriorly and not attaining the eyes. Second segment of the abdomen longer than the two following united, separated from the first by a straight* suture.

The validity of the separation of this as a distinct group in our fauna seems somewhat doubtful, the only character by means of which it may be distinguished from the preceding group is found in the position of the

* Lacordaire says arcuate. It really appears so when the scales and crust remain, but when these are removed the suture will be found as stated.

Digitized by Google

scrobes. I have adopted a group name in accordance with the only genus known to me, as experience has already shown that groups of genera formed on the Lacordairean basis are not at all times those which form from the basis adopted in the present memoir which is but a modification and amplification of that suggested by Dr. LeConte.

One genus occurs in our fauna.

PHYXELIS Sch.

Phyxelis Schönh. Curc. vii, 1, p. 122.

Rostrum longer and somewhat narrower than the head, slightly arcuate, parallel, sub-angular, tip slightly emarginate with small smooth space limited by an elevated line. Scrobes visible from above, moderately deep badly defined, arcuate and not attaining the eyes. Antennæ moderate, scape gradually clavate attaining the margin of the thorax; funicle 7-jointed, 1–2 longer, 3–7 oval, club oval. Eyes oval, slightly oblique, coarsely granulated. Thorax broader than long, sides moderately arcuate, ocular lobes feeble, apex and base truncate. Scutellum invisible. Elytra rather broadly oval, convex, not wider at base than the thorax and feebly emarginate, humeri obtuse. Metasternal side pieces narrow connate without distinct suture. Intercoxal process broad, truncate. Second segment of abdomen longer than the two following together, first suture straight. Tibiæ mucronate, posterior corbels open. Tarsi short, stout, fourth joint deeply bilobed, claws small, free.

The presence of thoracic lobes is the only character in the way of placing this genus near *Cercopeus*.

P. rigidus Say (*Barynotus*) Curc. of N. A. p. 2; Schönh. Curc. ii, p. 312; Schönh. (*Phyxelis*) Curc. vii, 1, p. 124; *glomerosus* Boh. Sch. Curc. vii, 1, p. 123; *setiferus* Boh. loc. cit. p. 124.

Form ovate, piceous, surface moderately densely scaly and obscured by a luteous exudation coating. Head and rostrum longer than the thorax, densely scaly and sparsely setigerous, rostrum at base with more or less distinct transverse impression. Thorax somewhat variable in form, broader than long, sides moderately arcuate, usually narrowed in front, base feebly arcuate, disc convex, median line more or less impressed, surface densely scaly and sparsely setigerous. Elytra broadly oval, base truncate, humeri sub-rectangular, disc moderately convex indistinctly striate, intervals feebly convex, each with a single row of not closely placed sub-erect setæ. Body beneath clothed as above, legs sparsely setigerous. Length .14–.20 inch; 3.5–5 mm.

The color of the coating varies very greatly, usually pale ochreous sometimes dark brown, and it adheres so closely and so obscures the true sculpture of the insect as to render it almost impossible to obtain an accurate idea of the surface. I cannot find any reason for distinguishing three species in our fauna.

Occurs from Canada to Georgia. Not rare.

Digitized by Google

Tribe II. OTIORHYNCHINI.

Antennæ long, scape always passing the eyes behind. Scrobes variable but never at the same time linear and directed inferiorly. Metasternal side pieces usually entirely concealed by the elytra, rarely of moderate width. Mesosternal epimera small. Elytral striæ entire in all our genera, tenth or marginal always distant from the preceding in its entire length.

It is extremely difficult to give characters which define tribes of Rhynchophora with any degree of certainty, and it is frequently found that a species can only be assigned a position by the consideration of almost its entire structure with considerable allowance for facies, and not a little, by the experience of the student.

Some of the genera placed in the *Otiorhynchini* by Lacordaire, have been removed and will constitute portions of tribes in Division ii, with wide metasternal side pieces.

Our genera form four groups which may be distinguished as follows :

Funicle 6-jointed ; articular surface of hind tibiæ enclosed, tips of hind tibiæ truncate with broad oval space .... **Agraphi.**

Funicle 7-jointed ; articular surface free, tips of hind tibiæ with a single row of fimbriæ.

Claws free.

Antennæ long ; outer joints of funicle long. **Otiorhynchi.**

Antennæ shorter; outer joints short or moniliform .... **Trachyphlœi.**

Claws connate.

Antennæ as in *Otiorhynchi*........................ **Periteli.**

The *Periteli* are placed after the *Otiorhynchi* from their greater similarity of form and structure, the only difference between the two tribes is found in the claws.

Group I. Agraphi.

Antennæ moderate, scape longer than the funicle and club, moderately arcuate ; funicle 6-jointed ; club broadly oval slightly flattened, composed in great part of the first joint only, the other joints retracted and very in distinct. Tarsi long, slender, third joint very feebly emarginate and scarcely wider than the second. Hind tibiæ truncate at tip with broad, oval smooth space, cotyloid cavities internal. Anterior tibiæ with outer apical angle slightly prolonged ; anterior and middle tibiæ with inner angle mucronate.

The above characters appear to warrant the separation of *Agraphus* as a group by itself as suggested by Lacordaire who, however, failed to notice the structure of the antennal club and placed the genus in a group in which the hinder cotyloid cavities are open. These latter are really very strongly cavernous, more so in fact than in any other genus in our fauna.

Agraphus alone constitutes this group.

Digitized by Google

AGRAPHUS Sch.

Agraphus Schönherr, Gen. Curc. ii, p. 640.

Rostrum longer and narrower than the head, with an oblique constriction behind the scrobes, tip slightly declivous and truncate. Scrobes distant from the tip, deep in front and enclosed by an elevated margin, broadly open and shallow behind. Front with shallow transverse impression. Eyes oval, oblique, pointed beneath. Antennæ sub-median, densely scaly, scape attaining the thorax, funicle much shorter than the scape, 6-jointed, joints gradually shorter, sixth rather close to the club; the latter oval obtuse, scaly, composed in great part of the first joint only. Thorax oval, truncate at apex, broadly arcuate at base. Scutellum small, triangular. Elytra very convex oval, slightly attenuate behind. Legs moderate, thighs rather strongly clavate, tibiæ slightly dilated at tip. Tarsi slender, ciliate beneath, three fourths the length of the tibiæ, joint three feebly emarginate and scarcely wider than the second. Claws free. Second segment of abdomen not longer than the two following united, separated from the first by a nearly straight suture.

A. bellicus Say, (*Peritelus*) Curculionidæ, p. 13; Am. Ent. i, p. 274; *leucophæus* Gyll. Sch. Gen. Curc. ii, p. 641.

Form elongate oval, densely covered with cinereous scales faintly clouded. Head and rostrum slightly longer than the thorax. Thorax oval, broader than long, sides moderately arcuate, apex narrower than the base and slightly truncate, base arcuate, surface regularly convex, sparsely and coarsely punctured. Elytra oval slightly attenuate posteriorly, not wider at base than the thorax, nearly three times as long and conjointly emarginate at base; surface finely striate, striæ distantly punctured, intervals very feebly convex. Body beneath and legs densely covered with cinereous scales, and the tibiæ sparsely fimbriate. Length .26–.34 inch; 6.5–8.5 mm.

Occurs from Pennsylvania to Florida.

Group II. Otiorhynchi.

Antennæ long, rather slender, scape passing slightly the anterior margin of the thorax, funicle 7-jointed, first two joints longer than the others, joints 3–7 obconical, moderately long, club oval, acute at tip. Cotyloid cavities of hind tibiæ terminal. Tarsal claws free.

The longer antennæ as defined by the form of the outer joints of the funicle, alone distinguish this group from the next. The genera are not numerous and are known by the characters given in the following table:

Metasternal side pieces entirely concealed by the elytra; suture obliterated. Hind tibiæ with two short fixed spurs........................ **OTIORHYNCHUS.**

Metasternal side pieces linear; suture distinct in its entire length.

Hind tibiæ with two short, fixed, terminal spurs, first suture of abdomen feebly arcuate. Front slightly transversely impressed.................... .... **SCIOPITHES.**

Hind tibiæ without terminal spurs, first suture strongly arcuate at middle. Front not impressed................................ ..... **AGRONUS.**

Metasternal side pieces moderately wide, suture distinct.

Hind tibiæ without terminal spurs; first suture of abdomen strongly arcuate at middle.. **NEOPTOCHUS.**

The fixed spurs of the hind tibiæ appear not to have been noticed by any author; they are in fact, difficult to see in some species, while in others, quite large and prominent (*O. maurus*). I am not at present aware of the occurrence outside of the tribe Otiorhynchini of any similar structure. *Thecesternus* has the tibiæ bimucronate. The female of *Ithycerus* presents curious characters. On each tibia in addition to the usual mucro are two spurs, one of which at least is moveable. The male has the tibiæ simply mucronate.

OTIORHYNCHUS Germ.

Otiorhynchus Germar, Ins. Spec. nov. p. 343.

Rostrum as long as the head, moderately robust, more or less dilated at tip which is notched at middle. Antennæ anterior long; scape long, very slightly arcuate not longer than the funicle and club, attaining the thorax; funicle 7-jointed, first two joints longer, joints 3–7 obconical. Scrobes superior deep, sides strongly divaricate behind. Eyes rounded or slightly oval. Thorax oval, longer than wide. Elytra variable, broadly or elongate oval. Scutellum very small or indistinct. Legs moderately long, thighs clavate, tibiæ feebly arcuate near the tip. Cotyloid cavities of hind tibiæ terminal. Tarsi moderately dilated, spongy pubescent beneath, third joint deeply bilobed. Second abdominal segment not as long as the two following united, separated from the first by an arcuate suture.

This genus contains in our fauna species which have been introduced from Europe, and which have established themselves in the north-eastern parts of our territory. Two are found in Greenland, which also occur in the extreme north of Europe, their distribution being due to natural laws and not through the agency of commerce.

The species are known as follows:

Femora toothed.

Tooth very small. Rostrum sulcate, at tip with a bifid carina, elytra sulcate.................................. **sulcatus.**

Tooth large, rostrum not sulcate, tip not carinate, elytra not sulcate .... **ligneus.**

Femora not toothed.

Digitized by Google

Thorax coarsely granulate.
Rostrum sulcate, elytra with rough sculpture...... **rugifrons.**
Rostrum finely carinate, elytra feebly sculptured.. **maurus.**
Thorax smooth, finely punctured.
Rostrum flat above, elytra nearly smooth .... **monticola.**

O. sulcatus Fab. Syst. Ent. p. 155; Herbst, Käfer, vi, p. 347, pl. 87, fig. 5, ? *Sayi* Boh. Sch. Gen. Curc. vii, p. 523. (European synonymy omitted).

Form oblong, brown black, sub-opaque. Rostrum sulcate at middle, tip emarginate and with a V shaped carina; surface sparsely and coarsely punctured and sparsely hairy. Thorax sub-cylindrical, sides moderately arcuate, widest in front of middle, not longer than wide, surface with rounded tubercles rather closely placed, each bearing a short hair. Elytra oblong oval, disc slightly flattened, humeri obtusely rounded, surface broadly striate, striæ coarsely punctured, intervals feebly convex and with a row of shining rounded tubercles rather closely placed and with small patches of short yellowish hair irregularly placed. Body beneath black, shining and very sparsely hairy. Femora strongly clavate, deeply sinuate near the tip and with a very small acute tooth. Length .34 inch; 8.5 mm.

This species has been so often described in easily accessible European publications, that I consider it unnecessary to add to the above description, this with the table being sufficient to enable it to be recognized by the student of our fauna.

Occurs in Massachusetts, Canada, Newfoundland and Nova Scotia.

O. ligneus Oliv. Ent. v, 83, p. 378, pl. 31, fig. 473.

Form oblong, color piceous, shining. Rostrum flat, emarginate at tip, surface very coarsely and closely punctured, between the eyes a deep puncture. Thorax nearly spherical, truncate at apex and base, surface tuberculate, (at middle the tubercles become confluent in rows with deep sulci between them), each tubercle punctured at summit and bearing a short hair. Elytra oval, striate at the sides, striæ obsolete on the disc and with coarse punctures closely placed, intervals flat on the disc and feebly muricate, at sides moderately convex and slightly tuberculate. Legs piceo-rufous, femora clavate, sinuate near the tip and with a moderately strong tooth bearing a denticle on its free edge. Length .20 inch; 5 mm.

This is the smallest species which has occurred with us, and may be easily known by the femoral armature and the nearly spherical thorax with its peculiar sculpture.

Occurs in the New England States.

O. rugifrons Gyll. Ins. Suec. iii, p. 319.

This species resembles *sulcatus*, but is somewhat more robust and with the elytra more broadly oval, and the humeri more oblique. The femora are moderately sinuate near the tip and without tooth. The surface is

Digitized by Google

sparsely hairy, the hairs of the elytra being short and arranged in a double row on each interval. Length .38 inch ; 9.5 mm.

Occurs in the Middle States.

O. maurus Gyll, Ins. Suec. iii, p. 293 ; *nodosus* O. Fabr. Fauna Grönl. p. 187.

Black, moderately shining. Rostrum flat above, without triangular impression at tip, obtusely carinate at middle, a slight perforation between the eyes, surface coarsely punctured, sparsely pubescent. Thorax slightly broader than long, sides arcuate, apex truncate, base feebly arcuate, surface densely tuberculate and sparsely pubescent. Elytra regularly oval, finely striate, striæ coarsely punctured, intervals flat, slightly wrinkled and with patches of scale-like hairs irregularly interspersed. Body beneath and legs black, femora unarmed. Length .38 inch ; 9.5 mm.

Easily known by the comparatively smooth elytra and granulate thorax.

Occurs in Greenland.

O. monticola Germ. Ins. Spec. nov. p. 361 ; *arcticus* O. Fabr. Fauna Grönl. p. 188.

Oblong oval, black, shining. Rostrum above flat, sparsely punctured, median line smooth, a puncture between the eyes. Thorax longer than wide, widest in front of middle, sides moderately arcuate and very slightly sinuate near the base ; surface shining, finely and rather sparsely punctured. Elytra regularly oval, surface not striate, but with moderate punctures in indistinct rows, intervals irregularly bi-seriately punctulate. Body beneath black, shining, more rugulose than above. Femora unarmed. Length .26–.28 inch ; 6.5–7 mm.

The tip of the rostrum on each side of the emargination is slightly prolonged in an obtusely conical process. The same may be seen though to a much less extent in the other species. This species is easily known by its smooth shining surface and sparsely punctured thorax.

Occurs in Greenland.

SCIOPITHES, n. g.

Rostrum stout, not longer than the head, cylindrical and slightly narrowed toward the tip which is emarginate and with a crescentic impressed space, a very feeble impression between the eyes. Scrobes superior, cavernous and of oval form. Antennæ long, scape passing the anterior margin of the thorax, rather slender, gradually thicker toward tip and rather strongly arcuate ; funicle 7-jointed, the first two joints moderately long, joints 3–7 obconical gradually shorter ; club elongate oval. Eyes oval, slightly longitudinal. Thorax cylindrical, sides slightly arcuate. Elytra rather broadly oval, moderately inflated. Scutellum wanting. Metasternum very short. Intercoxal process of abdomen short, broad, truncate in front, second segment but little longer than the third separated from the first by a nearly straight suture. Cotyloid cavities of hind tibiæ terminal, the tibiæ with two short fixed spurs ; anterior and middle tibiæ finely mucronate. Claws free.

Digitized by Google

This genus cannot by the above characters be referred to any other group, established by Lacordaire, than the *Otiorhynchides vrais*, in which I can find no genus with similarly formed antennal scrobes. The metasternal side pieces although very narrow are distinct and have the suture plainly visible in its entire length.

This genus represents in our fauna *Sciobius* of South Africa.

S. obscurus, n. sp.

Form oval, body densely covered with luteous scales. elytra with darker discal space limited behind by a very sinuous line. Head and rostrum together very little longer than the thorax, the latter with an extremely fine median carina, surface sparsely punctured. Thorax cylindrical, slightly wider than long, sides feebly arcuate, apex and base truncate, surface coarsely but sparsely punctured and with a shallow fovea on each side near the base, scales dense, color luteous, fine median and broader lateral lines paler. Elytra oval, very slightly attenuate behind, not wider at base than thorax, one-third longer than wide, striate, striæ punctured, intervals flat. the middle with one, the other with two rows of very short hairs, surface densely covered with luteous scales, with large irregular discal, darker space limited behind by a very irregularly sinuous line. Body beneath sparsely scaly. Legs densely scaly and sparsely hairy. Length .22–.24 inch ; 5.5–6 mm.

The style of coloration of this species nearly that of *Cercopeus*. It may however, become entirely unicolorous.

Occurs in California, Oregon and Vancouver.

AGRONUS, n. g.

Rostrum slightly longer than the head, and slightly narrower to tip, cylindrical above, slightly flattened and with fine groove, tip truncate with semicircular naked space. Scrobes superior, very short, cavernous, slightly converging and terminal. Eyes small, round, moderately prominent. Antennæ long, sub-terminal, scape passing the anterior margin of thorax, very gradually thicker to tip and feebly arcuate, funicle 7-jointed, first two joints longer, joints 3–7 obconical and gradually shorter; club elongate oval. Thorax cylindrical, base and apex truncate, sides very feebly arcuate. Elytra oblong oval, not wider at base than thorax. Scutellum wanting. Metasternum short, side pieces narrow, suture indistinct. Intercoxal process of abdomen short, broad, truncate, second segment longer than each of the two following, separated from the first by an arcuate suture. Cotyloid cavities of hind tibiæ terminal, the margin simply fimbriate with short spinules and without terminal spurs. Tibiæ not mucronate. Claws small, free.

This genus resembles the preceding in most of its characters, and differs in the absence of spurs to the hind and the mucro to the anterior and middle tibiæ ; the less distinct metasternal side pieces and the structure of the second abdominal segment. Allied to *Parameira* by Seidlitz' table, differs in its shorter scrobe and more slender antennæ.

Digitized by Google

A. cinerarius, n. sp.

Oblong oval, densely covered with uniformly colored cinereous scales. Rostrum and head longer than the thorax, sparsely punctured. Antennæ rufous, sparsely hairy. Thorax cylindrical, slightly wider than long, apex truncate and slightly narrower than the base, sides feebly arcuate, surface sparsely punctured. Elytra oval, slightly oblong, striate, striæ coarsely and rather closely punctured, intervals flat, densely scaly and with short, semi-erect scale-like hairs. Body beneath very sparsely clothed with short hairs. Legs rufous, very sparsely scaly and pubescent. Length .14–.18 inch; 3.5–4.5 mm.

A rather inconspicuous insect resembling the preceding in form but more elongate. In some specimens, probably males, the elytral intervals are slightly alternating in width.

Collected by Mr. G. R. Crotch in the Sierra Nevada Mountains of California, near Lakes Tahoe and Donner.

A. deciduus, n. sp.

Form oblong, piceous, moderately densely clothed with scales of pearly lustre. Head and rostrum slightly longer than the thorax, densely scaly and sparsely punctured, with short, pale, erect hairs sparsely placed. Antennæ piceous. Thorax broader than long, cylindrical, sides feebly arcuate, disc moderately convex, surface sparsely punctured and slightly rugulose and sparsely covered with pearly scales and erect pubescence. Elytra oblong oval, obsoletely striate, striæ with moderately coarse and close punctures, intervals flat, not densely scaly and each with two rows of moderately long erect pale hairs. Body beneath black, sparsely scaly and hairy. Legs sparsely scaly and hairy, piceous. Length .16 inch; 4 mm.

Of the same form as the preceding, and somewhat recalling the form of *Scythropus*. Differs from *cinerarius* by the pearly scales less densely placed and more deciduous and by the much longer hairs covering the surface.

Collected at San Francisco.

NEOPTOCHUS n. g.

Rostrum stout, not longer and as wide as the head, cylindrical, flattened above, tip emarginate. Scrobes lateral, terminal, cavernous in front, shallow and broad behind, attaining the eyes. Eyes round, moderately convex. Antennæ long, scaly; scape passing the anterior margin of the thorax, slender, very slightly thickening towards the tip, arcuate; funicle 7-jointed, first two joints long, joints 3–7 conical gradually decreasing in length, club oval. Thorax short, cylindrical, sides feebly arcuate. Scutellum absent. Elytra oval, moderately inflated. Metasternum short; side pieces moderate, suture distinct. Intercoxal process broad, truncate; second abdominal segment as long as the two following, separated from the first by a feebly arcuate suture. Cotyloid cavities of hind tibiæ terminal, tibiæ without fixed spurs or mucro, anterior and middle tibiæ not mucronate. Claws small, free.

Digitized by Google

The form of the only species composing this genus is much that of *Ptochus*.

N. adspersus Boh. (*Ptochus*) Sch. Gen. Curc. ii, p. 486; Seidl. Berl. Zeits. 1868. p. 41, (Beiheft); *tesselatus* Boh. loc. cit. p. 487.

Form oval, robust, densely clothed with pale cinereous scales, with obscure spots near the humeri in some specimens. Head and rostrum longer than the thorax. Rostrum with smooth crescentic space at tip, above slightly transversely concave; surface sparsely punctured and densely scaly. Thorax transverse, cylindrical, sides feebly arcuate, base and apex truncate, surface coarsely punctured and irregular, and moderately densely scaly. Elytra broadly oval, convex, three times the length of thorax, striate, striæ with distant punctures, intervals flat, densely scaly, each with a row of very short erect scales. Body beneath and legs densely scaly. Length .14–.16 inch; 3.5–4 mm.

This species from its *Ptochus*-like form cannot be confounded with any other in the present group, while the wider metasternal side pieces and the absence of the fixed spurs to the hind tibiæ, the lateral scrobes and scaly antennæ serve to distinguish the genus. Bohemann says the femora have a small tooth, probably from an error of observation, as on p. 487, the tooth is not mentioned in the synonym.

Appears to be not rare in Florida.

This insect has been referred to the genus *Ptochus* by Seidlitz (loc. supra cit.) an opinion which I cannot adopt, the broad intercoxal process and the free claws appear to me abundantly sufficient to separate it. Species with free claws are, however, admitted by Seidlitz in *Ptochus*.

Group III. Periteli.

Antennæ long, scape attaining or slightly passing the anterior margin of the thorax; funicle variable in length, 7-jointed; club oval. Tarsal claws connate.

The cotyloid surfaces of the hind tibiæ are entirely open in all the genera of this group, glabrous in six, scaly in the remainder. In the genera in our fauna the rostrum is comparatively or very short, nothing occurs at all approximating the length of that of *Peritelus griseus* of Europe. The alæ of the rostrum are divergent in but one genus, and then but feebly.

Our genera are as follows:

First abdominal suture straight. Scrobes lateral.
  Alæ of rostrum slightly divergent; first two joints of funicle equal.............................. **PARAPTOCHUS.**
First abdominal suture arcuate.
  Cotyloid surface of hind tibiæ glabrous. Eyes without orbital groove.
    Hind coxæ open externally; first abdominal segment behind them very short....... . . **MYLACUS.**
    Hind coxæ closed externally; first abdominal segment normal.

Digitized by Google

Scrobes superior and convergent above.
Rostrum longer than the head, scrobes very short terminal; body with scales and setæ .... **THRICOLEPIS.**
Rostrum short; scrobes nearly attaining the eyes; body scaly only............. **PERITELOPSIS.**
Scrobes more lateral not converging above.
Scape as long (or very nearly so) as the funicle; tibiæ finely denticulate within .... **GEODERCES.**
Scape much shorter than the funicle; tibiæ not denticulate..................... **ARAGNOMUS.**
Cotyloid surface of hind tibiæ densely scaly.
Scrobes superior, slightly convergent above.
Eyes indistinctly surrounded by a groove. Scape feebly arcuate....... **DYSTICHEUS.**
Scrobes lateral, not at all convergent.
Orbital groove deep.
Scape arcuate and slightly twisted; scrobes lateral, deep, and attaining the eyes...................................... **EUCYLLUS.**
Scape straight or very feebly arcuate.
Scrobes very shallow posteriorly, not attaining the eyes...................... **THINOXENUS.**
Scrobes deep, attaining the eyes......... **RHYPODES.**

The genera above indicated are so arranged as to exhibit a gradual transition from the Ptochoid forms of the preceding group to the Trachyphlœoid forms of the next. The rostrum tends to become shorter, also, as the advance is made from the first to the last genus. The vestiture varies. In one species *Mylacus saccatus* Lec., the surface is sparsely pubescent without scales, *Peritelopsis globiventris* Lec., is scaly only without trace of hairs or setæ; all the remaining species are densely scaly and with short erect setæ. As a general rule the metasternal side pieces are extremely narrow in the earlier genera (entirely concealed posteriorly in *Mylacus*) and become more distinctly wider in the later genera, the suture, however, is so very indistinct as to make it almost impossible to use the character systematically.

The scrobes vary greatly in form. In several genera they are plainly superior and rather short, converging above. In others it is not easy to determine whether to call them lateral or superior. When the scrobes are much more distinctly open when viewed from above than when seen from the sides they are called superior and conversely. None of our genera show a lateral form of scrobe such as is seen in *Omias* or *Lichenophagus.*

The occurrence of short fixed spurs to the hind tibiæ in addition to the

Digitized by Google

mucro and at all events entirely independently of it, is noticed here. In one genus their occurrence appears to be sexual, in others it cannot be so referred.

The occurrence of scaly tips to the hind tibiæ does not appear, from descriptions, in any foreign genus of the group. Those in our fauna might form a distinct group from the Periteli, and would have been so constituted, but I find on examination that *Lichenophagus* would occupy an intermediate place by the groove surrounding the eyes and by the entirely glabrous tips of the hind tibiæ. It is also to be regretted that one of our species only appears to be congeneric with any previously described.

PARAPTOCHUS Seidl.

Paraptochus Seidlitz, Berl. Zeitschr, 1868. Beiheft, p. 35.

Rostrum scarcely as long as the head, and separated by an arcuate impression, robust, sub-quadrangular, tip emarginate with a smooth space limited by an angular line, alæ moderately divergent. Scrobes deep in front, moderately arcuate, gradually shallower posteriorly and attaining the eye. Antennæ moderate, sub-terminal, scaly; scape, feebly clavate, slightly arcuate and barely attaining the margin of the thorax; funicle 7-jointed, first two joints longer equal, joints 3–7 gradually shorter, club oval. Eyes round, coarsely granulated and not prominent. Thorax cylindrical, slightly narrower in front, sides feebly arcuate. Scutellum wanting. Elytra oval, convex. Metasternal side pieces indistinct, narrow. Intercoxal process of abdomen broad, truncate, second abdominal segment not as long as the two following united and separated from the first by a straight suture. Claws connate.

The above genus contains only *Peritelus sellatus* Boh. The straight first abdominal suture excludes it from the genus to which it has been referred, and gives it considerable affinity with *Caterectus*.

P. sellatus Boh. (*Peritelus*) Eugen. Resa 1859, p. 126; *californicus* (*Paraptochus*) Seidl. Berl. Zeitschr. 1868, Beiheft, p. 35.

Form oval, moderately robust. Head and rostrum as long as the thorax, rostrum with fine median line, surface densely scaly, scales dark cinereous, with whitish setæ sparsely placed. Thorax cylindrical, slightly narrower in front, broader than long, sides feebly arcuate, apex and base truncate, disc moderately convex, coarsely and deeply punctured, surface densely scaly and with erect whitish setæ, scales brownish in a broad median band, pale cinereous at the sides. Elytra oval, slightly inflated, nearly three times as long as the thorax, striate, striæ punctured, intervals flat with erect setæ irregularly placed, surface densely covered with cinereous scales with large discal pale-brownish space limited behind by a sinuous darker line. Body beneath less densely scaly. Length .18 inch; 4.5 mm.

When deprived of scales the surface color is pale brownish. The anterior and middle tibiæ are very feebly mucronate and the hind tibiæ of the ♀ have two short fixed spurs. The color of the scales varies and the large

Digitized by Google

discal spot of the elytra may become evanescent. The erect hairs are also variable, and assume the color of the surface in which they are placed.

Collected at Crystal Springs, California, by Mr. G. R. Crotch.

MYLACUS Sch.

Mylacus Schön. Gen. Curc. viii, 1, p. 144.

Rostrum as long as the head and slightly narrower to the tip which is very feebly emarginate and with smooth space, above broadly but feebly channeled, a feeble transverse impression at base, alæ feebly prominent. Scrobes superior, very slightly convergent, deep in front, broadly open and very shallow posteriorly, not attaining the eyes. Antennæ moderately long, sub-apical, sparsely hairy; scape gradually clavate, slightly arcuate, attaining the anterior margin of thorax; funicle 7-jointed, joints 1–2 longer, 3–7 sub-moniliform, club oval. Thorax cylindrical, short, transverse. Scutellum wanting. Elytra globoso-oval. Metasternum very short, side pieces entirely covered posteriorly by the elytra. Hind coxæ open exteriorly attaining the elytral margin. Intercoxal process of abdomen very broad, truncate; first segment deeply emarginate by the coxæ and very short behind them; second abdominal segment very little longer than the third separated from the first by an arcuate suture. Tibiæ not mucronate. Claws almost entirely connate. Body pubescent.

M. saccatus Lec. (*Ptochus*) Pacif. R. R. Rep. App. 1, p. 56.

Form oval, color black, shining, surface sparsely clothed with short cinereous pubesence. Head and rostrum one and a-half times longer than the thorax, moderately densely punctured, sparsely pubescent. Thorax transverse, twice as broad as long, sides feebly arcuate, apex and base truncate, disc convex, surface densely and at the sides confluently punctured, surface sparsely pubescent. Elytra broadly oval ♂ or globoso-oval ♀, with striæ of coarse punctures rather closely placed. Body beneath black, shining, metasternum densely punctured at the sides, abdomen smoother, more shining, surface sparsely pubescent. Legs black, sparsely pubescent. Length .12–.16 inch; 3–4 mm.

The hind tibiæ of the males have at the tip of the hind tibiæ immediately in front of the tarsal articulation a very feeble emargination, the female has two small fixed spurs.

There can be little doubt that this species should be referred to *Mylacus*. The characters given in the table supplemented by those above given will serve to distinguish it from all others in our fauna.

Occurs in California and Oregon.

THRICOLEPIS n. g.

Rostrum nearly as long as the head, slightly narrower towards the tip which is feebly emarginate, alæ not divergent. Scrobes superior, short, terminal, cavernous, somewhat reniform in shape and convergent above. Antennæ moderate, sub-terminal, scape feebly arcuate, attaining the margin of the thorax; funicle 7-jointed, longer than the scape, first two joints

Digitized by Google

longer than the others, joints 3–7 obconical; club oval. Eyes round. Thorax cylindrical, sides feebly arcuate, narrowed in front. Scutellum not visible. Elytra broadly oval, convex. Intercoxal process broad, truncate. Second segment of abdomen as long as the two following united, separated from the first by a strongly arcuate suture. Tibiæ not mucronate. Claws connate. Body scaly and with erect setæ.

This genus is closely allied to *Peritelus*. It differs at first sight in the vestiture of the body. The scrobes are much shorter and very decidedly convergent above, the alæ not divergent, antennæ, especially the scape, shorter. The genus is also allied to *Mylacus* in which, however, the surface is pubescent.

Two species are known to me, both Western.

T. inornata, n. sp.

Form oval, moderately robust. Head and rostrum longer than the thorax, surface sparsely punctured and not densely scaly. Antennæ rufo-testaceous, sparsely hairy. Thorax cylindrical slightly wider than long, apex and base truncate, sides feebly arcuate, slightly narrower in front and very feebly constricted at the sides behind the apex; surface coarsely and deeply punctured, sparsely scaly and with erect hairs. Elytra nearly three times as long as the thorax, oval, slightly inflated, with rows of moderately coarse, closely placed punctures, intervals flat, moderately densely scaly and with a row of short black erect setæ. Body beneath sparsely scaly, abdomen sparsely punctured and very sparsely hairy. Legs rufo-testaceous or slightly darker, sparsely hairy. Length .14 inch; 3.5 mm.

The scales covering the body are of pearly lustre and very easily removed, and beneath them the surface is black and shining. The elytra are not striate, the punctures merely form regular rows and are of large size and rather closely placed. In some specimens of narrower form, and which are probably males, the striæ of the disc are slightly impressed near the base. Specimens occur of slightly larger and smaller size than the measurement given.

Occurs from northern California to Utah.

T. simulator, n. sp.

Form oval, moderately robust. Head and rostrum longer than the thorax, surface very densely scaly and with very short setæ. Antennæ pale rufous, slightly hairy, scape sparsely scaly. Thorax wider than long, sub-cylindrical, slightly narrowed in front, base and apex truncate, sides feebly arcuate, modertely convex, surface coarsely and rather deeply punctured, densely scaly, scales cinereous and with a broad median space darker. Elytra oval, slightly inflated, surface finely striate and with rather small punctures distantly placed, intervals flat, densely covered with cinereous scales, with fuscous spots irregularly placed, a sinuous band of the same color at the posterior declivity and with very short erect setæ in a single row on each interval. Body beneath moderately densely scaly. Legs rufous, moderately densely scaly and with short hairs. Length .12 inch; 3 mm.

Digitized by Google

This species imitates some of the least distinctly marked specimens of *Paraptochus sellatus*. The scales are very densely placed and are closely adherent to and conceal the surface. Their color is pale, cinereous, except a broad median thoracic space and the few spots near the base of the elytra and the very irregular line at the declivity which are fuscous. This species and the preceding are similar in form to *Peritelus griseus* of Europe, and are about two-thirds the size.

Collected at Fort Tejon, California, by Mr. G. R. Crotch.

PERITELOPSIS n. g.

Rostrum not as long as the head, slightly flattened, narrower to tip which is feebly emarginate, alæ not divergent. Scrobes superior, cavernous, very slightly arcuate, convergent above, attaining the eyes. Eyes very slightly oval. Antennæ (entirely wanting) apical. Thorax cylindrical, narrower in front, sides moderately arcuate. Scutellum small. Elytra sub-globoso-oval. Metasternal side pieces extremely narrow. Intercoxal process broad, truncate. Second abdominal segment scarcely as long as the two following separated from the first by an arcuate suture. Femora moderately clavate, tibiæ finely mucronate, claws connate. Body scaly.

This genus is doubtless very near *Peritelus*. The alæ of the rostrum are not at all divergent, and the rostrum very short, Possibly the genus might enter one of Seidlitz' groups of *Peritelus*.

P. globiventris Lec. (*Ptochus*) Pacif. R. R. Rep. App. 1, p. 56.

Form oval, surface covered but not densely, with scales of a pearly lustre. Head and rostrum scarcely longer than the thorax, rostrum with a smooth space at tip, limited by an angulated line, surface coarsely and deeply punctured and sparsely scaly, vertex with a short linear impression. Thorax broader than long, slightly narrower in front, sides moderately arcuate, apex and base truncate, disc moderately convex, coarsely and deeply punctured, surface sparsely scaly. Elytra sub-globoso-oval, longer than broad, striate, striæ (those of disc at base not impressed) with moderate punctures not closely placed, intervals at sides and apex slightly convex, surface scaly. Body beneath coarsely punctured, sparsely scaly, abdomen very sparsely punctured and with few hairs. Legs piceous, sparsely scaly and hairy. Length .16 inch ; 4 mm.

The form of this insect is nearly that of *Peritelus griseus*, but with a much shorter rostrum. The scales of the surface are not densely placed, and the piceous color of the body is readily seen between them.

One specimen deprived of antennæ, from California.

GEODERCES n. g.

Rostrum nearly as long as the head, robust, parallel, sub-cylindrical, at base a feeble arcuate impression, tip feebly emarginate, a smooth space limited behind by an angulate line, alæ not prominent. Scrobes lateral, narrow, not attaining the eyes, crescentic when viewed laterally. Antennæ

Digitized by Google

moderately long, scape very nearly as long as the funicle, slightly passing the anterior margin of thorax; funicle 7-jointed, first two joints longer, joints 3–7 elongate, obconical gradually shorter; club elongate oval. Eyes round, moderately prominent. Thorax oval, truncate at apex and base. Scutellum not visible between the elytra. Elytra oval convex. Metasternum short, side pieces narrow, indistinct. Intercoxal process broad, truncate; second segment of abdomen shorter than the two following united, separated from the first by a feebly arcuate suture. Tibiæ with very short mucro at tip, and very minutely denticulate internally. Claws connate. Surface densely scaly and with short erect hairs.

This genus, of which *Trachyphlœus melanothrix* Kby. is the type, has nothing at all resembling it outside of our fauna. It may be said to resemble *Trigonoscuta* in form with a somewhat narrower thorax. In addition to the minute mucro, the hind tibiæ have, in addition, two short fixed spurs. As these are found in all the specimens before me, I cannot suppose them to be sexual. The denticulations of the tibiæ are minute, and though sufficiently distinct may easily be overlooked. This genus seems by the table of Seidlitz to be allied to *Epiphaneus*.

Two species occur in our fauna, of very similar aspect, which differ as follows:

Second joint of funicle distinctly longer than the first; erect hairs of elytra very short, feebly erect and all black .... **melanothrix.**
Second joint slightly shorter than the first; elytra hairs longer, erect and white and black intermixed........ **incomptus.**

G. melanothrix Kby. (*Trachyphlœus*) Fauna Am. Bor. iv, p. 202.

Form oval, robust, densely covered with brownish scales, with short paler markings very indistinct, and with very short, semi-erect blackish hairs very sparsely placed. Head and rostrum very slightly longer than the thorax, a short impressed line at vertex, rostrum flat, coarsely but sparsely punctured and densely scaly. Antennæ castaneous, sparsely pubescent. Thorax oval, very slightly wider than long, truncate at apex and base, a slight constriction one-fourth behind the apex, sides arcuate, disc moderately convex, coarsely but very evenly perforato-punctate, surface densely covered with brownish scales with a narrow paler line at the sides. Elytra oval, sub-globose, about one-fourth longer than wide, base emarginate, humeri oblique, sides sub-parallel for a short distance at middle, apex very obtusely rounded, surface densely covered with brownish scales with indistinct paler spaces at the sides of the declivity, and with striæ of moderate punctures not very closely placed. Body beneath castaneous, coarsely punctured and scaly, abdomen more sparsely punctured and with hair-like scales. Legs densely covered with brownish scales and sparsely hairy, femora with a broad ring of whitish scales near the tip. Length .22–.32 inch; 5.5–8 mm.

In those specimens with the markings more clearly defined, the narrow pale line of scales at the side of the thorax continues on the elytra, becom

Digitized by Google

ing broader as it passes posteriorly, where it is bounded in front and behind by a line of darker scales. I have two specimens before me of an entirely uniform pale-brown color.

Occurs in Canada and New York.

G. incomptus, n. sp.*

This species so closely resembles *melanothrix* in form, size and color that it is unnecessary to add any description. It differs only in the characters given in the short table, so that if the description of *melanothrix* be repeated with those changes only, it will equally apply to this one.

Occurs from San Francisco to Vancouver.

ARAGNOMUS n. g.

Rostrum shorter than the head, broader than long, flattened above, a feeble transverse impression at base, tip feebly emarginate and with a smooth crescentic space limited behind by a curved line. Scrobes sublateral, not convergent above, cavernous, nearly attaining the eyes. Antennæ scaly, moderate ; scape slightly arcuate, barely attaining the margin of the thorax ; funicle 7-jointed, nearly one-third longer than the scape, first joint nearly equal to the two following, joints 2–7 obconical, gradually decreasing in length ; club oval. Eyes rather small, round, not prominent. Thorax cylindrical, sides feebly arcuate at middle only. Scutellum invisible. Elytra oval. Intercoxal process broad, truncate. Second segment of abdomen as long as the two following, separated from the first by an arcuate suture. Anterior tibiæ feebly mucronate. Claws connate.

This insect recalls in smaller size *Paraptochus sellatus* with less broad elytra. The eyes are more distant from the thoracic margin than is seen in any of the other genera of the group, and the head and rostrum rather large when compared with the thorax. From Seidlitz's table this genus appears to occupy a doubtful position. The frontal impression is sufficiently distinct to ally it to *Sciobius*, etc., but the structure of the abdomen will not warrant such position. The scrobes are moreover in such position that it is impossible to say whether they should be called superior or lateral. They are by no means lateral in the manner of *Trachyphlœus* and *Lichenophagus*.

A. griseus, n. sp.

Form oval, robust, surface densely covered with cinereous scales, with sparsely placed, erect, black setæ, longer on the elytra. Head and rostrum longer than the thorax, a slight frontal line, surface sparsely and deeply punctured, densely scaly, and with short erect hairs. Thorax slightly broader than long, cylindrical, truncate at apex and base, sides suddenly arcuate at middle, disc moderately convex, coarsely and regularly

* No description of this species has until now appeared. I adopt the specific name by which it is known in our cabinets. Mention of the species first occurs in a catalogue of insects collected on the survey of the Pacif. R. R. where it is called *Trachyplœus*. See Pacif. R. R. Rep., App. 1, p. 21.

Digitized by Google

punctured, densely scaly, a broad median stripe fuscous, sides cinereous, sparsely setose. Elytra oval, moderately convex, striate, striæ with rather fine, closely placed punctures, intervals flat; surface densely covered with cinereous scales, darker on the disc and with a transverse very sinuous line at the declivity, and with erect black setæ in regular rows on the intervals. Body beneath densely scaly. Legs densely scaly and sparsely setose. Length .14 inch; 3.5 mm.

The surface color when deprived of scales is brownish testaceous.

One specimen California, no special locality known.

DYSTICHEUS n. g.

Rostrum as long as the head, robust, cylindrical, slightly flattened, very slightly arcuately narrowed from base to tip; tip slightly emarginate with smooth crescentic space limited behind by a ridge, upper side moderately deeply sulcate, groove slightly wider toward the tip. Scrobes superior very feebly convergent above, broadly open in their entire length (the sides very widely divergent behind), very shallow posteriorly, not attaining the eyes. Eyes moderate, coarsely granulated and surrounded by a fine groove. Antennæ moderately long, scape slightly arcuate and passing the anterior margin of the thorax; funicle 7-jointed, one-third longer than the scape, first joint longest, the others elongate obconical, gradually decreasing in length; club elongate, oval, acute. Thorax cylindrical, sides moderately arcuate. Scutellum invisible. Elytra regularly oval. Metasternum short, side pieces narrow. Intercoxal process of abdomen broad, truncate. Second segment of abdomen nearly as long as the two following, separated from the first by an arcuate suture. Anterior and middle tibiæ with very short mucro, tips of hind tibiæ scaly. Claws connate. Body scaly and hispid.

The scrobes in their entire extent are more open than in any genus known in the group. The eyes are less distinctly surrounded by a groove than the following genera. I can find no foreign genus resembling it.

D. insignis, n. sp.

Form oval. Head and rostrum as long as the thorax, coarsely and deeply punctured, and rugulose, and sparsely scaly and with short erect setæ, except in the median groove which is nearly smooth and extends to the base of the rostrum. Thorax cylindrical, slightly narrower in front, broader than long, apex and base truncate, sides moderately arcuate, disc moderately convex, coarsely, densely and deeply punctured, sparsely scaly and with very short setæ. Elytra regularly oval, sides feebly arcuate, striate, striæ with coarse, quadrate, closely placed punctures, intervals flat, densely covered with cinereous scales of elongate form, with darker patches irregularly intermixed, and two irregular rows of scale-like, short, erect setæ. Body beneath piceous, coarsely and densely punctured, abdomen smooth, sparsely punctured, sparsely scaly and pubescent. Legs piceous, sparsely scaly. Length .16 inch; 4 mm.

One specimen collected in the southern portion of California.

Digitized by Google

EUCYLLUS n. g.

Rostrum not longer than the head, robust, slightly narrowed in front, alæ not divergent, tip emarginate and with a very narrow smooth space. Scrobes lateral, moderately deep, feebly arcuate, passing directly backwards and attaining the eyes. Antennæ long, scaly; scape arcuate and slightly twisted, passing slightly the anterior margin of the thorax; funicle 7-jointed, slightly longer than the scape; joints 1–2 long, the second longer than the first, third slightly shorter than the first, 4–7 obconical, gradually shorter, club rather small, oval. Thorax cylindrical, sides moderately arcuate. Scutellum invisible. Elytra oblong oval. Intercoxal process broad, truncate, second segment not as long as the two following, separated from the first by an arcuate suture. Tips of hind tibiæ scaly, anterior and middle tibiæ mucronate. Claws connate. Body scaly and hispid.

This genus would be placed by Seidlitz' table near *Trachyphlœus*.

E. vagans, n. sp.

Elongate oval, densely scaly and with greyish setiform hairs. Head and rostrum nearly as long as the thorax, densely covered with cinereous and pale-brownish scales intermixed, and with short erect hairs sparsely placed, surface sparsely punctured. Thorax cylindrical, truncate at apex and base, slightly wider than long, sides moderately arcuate, disc moderately convex, sparsely punctured, densely scaly and sparsely hairy. Elytra elongate oval, twice as long as wide, moderately convex, finely striate, striæ with rather fine punctures not closely placed; intervals flat, densely scaly and with a row of moderately long erect hairs on each interval. Body beneath densely scaly, and with very short setæ sparsely placed. Legs densely scaly, scales cinereous, femora with a darker ring near the tip. Length .20–.28 inch; 5–7 mm.

The scales covering the body vary in color from cinereous to ochreous; on the thorax is a broad median stripe of darker color, and the elytra have short brownish lines on the discal space, occupying alternate intervals.

Occurs in Arizona and parts of California adjacent.

THINOXENUS n. g.

Rostrum not longer than the head, robust, not narrower in front, above flat, tip feebly emarginate. Scrobes lateral, rather broadly open and with divergent sides, posteriorly very shallow and not attaining the eyes. Antennæ moderate, sub-terminal, scaly; scape very feebly arcuate, attaining the thoracic margin; funicle 7-jointed, slightly longer than the scape, joints 1–2 longer, the first longer than the second, joints 3–7 obconical; club small, elongate oval. Eyes small, round, not prominent. Thorax oval, slightly broader than long, truncate at apex and base. Scutellum indistinct. Elytra regularly oval. Intercoxal process broad, truncate; second segment not longer than the two following, separated from the first by an arcuate suture. Hind tibiæ scaly at tip, anterior and middle tibiæ indistinctly mucronate. Claws connate.

This genus is closely allied to the preceding, and has similar affinities;

Digitized by Google

differs in the form of the scape and the structure of the funicle. The scrobes are shorter and rather widely open and shallow posteriorly, and for a very short distance converge slightly above.

T. squalens, n. sp (*Trachyphlœus squalens* Lec. mss., see note under *Geod. incomptus*).

Form oval, densely clothed with brownish scales and with short black setæ. Head and rostrum slightly longer than the thorax, densely scaly, sparsely punctured and setose. Thorax one-fourth broader than long, apex truncate, base feebly arcuate, sides rather strongly arcuate, disc moderately convex, densely scaly, sparsely punctured and setose. Elytra one and a half times as long as wide, regularly oval, disc moderately convex, indistinctly striate, striæ not closely punctured, intervals flat, densely scaly, each with two rows of short setæ. Body beneath and legs densely scaly, sparsely setose. Length .18 inch ; 4.5 mm.

Similar in form to *Eu. vagans* but less elongate. In addition to the scales, the surface is covered with an exudation which almost entirely obliterates the appearance of the scales.

Not rare near the sea coast of California.

RHYPODES n. g.

Rostrum short, as broad as long, sub-quadrangular, flattened above, tip slightly emarginate. Scrobes lateral, moderately deep, very feebly arcuate and passing directly to the eyes. Antennæ moderate, sub-terminal, scaly; scape feebly arcuate, attaining the margin of the thorax ; funicle 7-jointed, shorter than the scape, joints 1–2 longer, the first longer than the second; joints 3-7 obconical, short; club oval, acuminate. Eyes small, round, deeply inserted, scarcely visible from above, and coarsely granulated. Thorax transversely oval. Scutellum invisible. Elytra regularly oval, humeri oblique. Intercoxal process broad, truncate. Tibiæ not mucronate, the posterior scaly at tip. Claws connate at base, divergent at tip, especially the anterior. Body densely scaly and with erect scales.

The form of the species of this genus is exactly that of *Trachyphlœus*. It differs from the preceding genus in the form of the scrobes, and from *Eucyllus* by its shorter form, and the structure of the antennæ. The eyes are so feebly prominent and the orbital groove so well defined, that the eyes are scarcely at all visible from above.

Rh. dilatatus, n. sp (*Trachyphlœus id.* Lec. mss. See note under *Geod. incomptus*).

Form of *Trachyphlœus*, densely covered with brownish scales with paler spots and with erect scales sparsely placed. Head and rostrum slightly longer than the thorax, densely scaly, sparsely punctured and with erect scales. Thorax nearly twice as wide as long, truncate at apex, base feebly, sides strongly arcuate, disc moderately convex, covered with brownish scales, variegated with paler, and with erect, short, clavate scales, sparsely placed, surface sparsely punctured. Elytra regularly oval,

Digitized by Google

finely striate, striæ not closely punctured, intervals flat, densely covered with brown and paler scales intermixed, each interval with two rows of not closely placed clavate scales. Body beneath and legs densely covered with brownish scales, the legs with semi-erect broad, paler scales. Length .14 inch ; 3.5 mm.

Occurs near the sea coast at San Diego, Cal.

Rh. brevicollis, n. sp.

Form oval, robust, densely covered with dark cinereous scales, and with erect scales sparsely placed. Head and rostrum as long as the thorax, densely scaly, with sparsely placed erect scales, and sparsely punctured. Thorax more than twice as wide as long, apex truncate, base feebly, sides strongly arcuate, disc moderately convex, sparsely punctured, densely scaly, a broad median space brownish, sides cinereous. Elytra broadly oval, scarcely longer than wide, sides broadly arcuate, disc moderately convex, finely striate, striæ finely punctured, intervals flat, densely covered with dark cinereous scales, each interval with a row of erect clavate scales. Body beneath more sparsely scaly than above. Length .10 inch ; 2.5 mm.

This species is much shorter and more robust than the preceding, the scaly vestiture is paler, and the body beneath less densely covered. The surface color when deprived of scales is pale castaneous.

One specimen from Colorado.

Group IV. TRACHYPHLŒI.

Antennæ moderate, scape attaining at most the margin of the thorax, usually the posterior margin of the eyes ; funicle 7-jointed, joints 1–2 longer than the others, joints 3–7 moniliform; club short, oval. Claws free.

Although composed of species differing considerably in their general aspect from those of the preceding group, no sharply-defined characters are found by which to distinguish the two. The antennæ are always less elongate, the scape long, feebly arcuate and slightly thicker to the tip, attains the thorax ; the funicle not longer than the scape, has the outer joints short, round and moniliform.

The following genera occur in our fauna :

Metathoracic side pieces entirely concealed ; eyes with distinct orbital groove.
  Scrobes superior, very short and deep not reaching the eyes ; anterior and middle tibiæ feebly mucronate.................................... CERCOPEUS.
  Scrobes lateral, long, passing directly backwards and enclosing the eyes ; tibiæ strongly mucronate.. CHÆTECHUS.
Metathoracic side pieces visible ; suture at least moderately distinct.
  Eyes with distinct orbital groove ; rostrum deeply transversely impressed at base.. ..TRACHYPHLŒUS.

Digitized by Google

CERCOPEUS Schönh.

Cercopeus Schönherr, Gen. Curc. vii, 1, p. 154.

Rostrum slightly longer and narrower than the head, feebly arcuate, angulate, truncate at tip. Scrobes superior, very short, deep. Antennæ subterminal, scape feebly arcuate attaining the thorax, funicle 7-jointed, joints 1–2 longer, the first stouter, joints 3–7 short moniliform, club moderate, oval. Eyes small rounded, surrounded by a very distinct groove. Thorax transversely oval, broadly arcuate on the sides, apex and base truncate. Elytra oval, very slightly attenuate behind, humeri broadly rounded. Tibiæ mucronate, the anterior more strongly. Claws free.

The deciduous pieces of the mandibles are cylindrical, flattened and very obtuse at tip. The scar left after the separation is extremely feeble.

C. chrysorrhœus Say (*Peritelus*) Curc., p. 13; Am. Ent. i. p. 274; Boh. Sch. Gen. Curc., ii, p. 517.

Form oval, color brownish, densely covered with ochreous scales, elytra with large discal space; somewhat cordiform in shape, darker in color. Head and rostrum moderately densely punctured. Thorax transversely oval, somewhat broader than long, apex and base truncate, sides rather strongly arcuate, disc moderately convex, densely punctured, becoming at times strigose at the middle, surface sparsely scaly. Elytra oval slightly attenuate behind, humeri broadly rounded, striate, striæ punctured, intervals flat, densely scaly and uniseriately setigerous. Body beneath very sparsely scaly. Legs sparsely scaly and slightly hairy. Length .12–.20 inch; 3–5 mm.

Variable in the color of the scales covering the surface from luteous to brown but always showing the darker, discal spot on the elytra.

Occurs from Pennsylvania to Georgia.

CHÆTECHUS n. g.

Rostrum not longer than the head and as stout, parallel, quadrangular, tip truncate and with small smooth triangular space. Scrobes lateral moderately deep, sides divergent passing above and beneath the eyes. Eyes small, round and with distinct orbital groove. Antennæ stout, insertion sub-median, scape moderately robust, feebly arcuate, attaining the margin of thorax, funicle 7-jointed, the first two longer and the first much stouter, joints 3–7 moniliform, club oval. Thorax feebly transversely oval. Elytra oblong oval, sides at middle parallel. Scutellum indistinct. Second segment of abdomen longer than either of the two following, separated from the first by a feebly arcuate suture. Intercoxal process of first segment very broad and short. Tibiæ strongly mucronate at tip. Claws free.

This genus is very distinct from all the other *Trachyphlœi* by the characters above given although not without considerable affinity with both *Trachyphlœus* and *Cathormiocerus*. The eyes are small, round, coarsely granulated, surrounded on all sides with a very distinct orbital groove. The scrobes are deep, pass directly backwards to the eye, the upper bounding

Digitized by Google

ridge passing over the eye so that a slight fold is formed almost concealing the eyes from above. The tibiæ are all rather strongly mucronate. From both the above genera the present may be known by the form of the scrobes.

C. setiger, n. sp.

Form oval, color brownish, surface sparsely scaly, elytra with rows of clavate scale-like hairs on the intervals. Rostrum densely punctured and with an indistinct median line. Thorax oval, broader than long, sides moderately arcuate, apex and base truncate, disc moderately convex, densely punctured, a slight post-apical and short transverse impression slightly behind the middle, surface with sparse scale-like hairs. Elytra slightly emarginate at base, oval, sides parallel for a slight extent, humeri broadly rounded, surface striate, striæ with coarse punctures, intervals feebly convex and with a row of scale-like, clavate hairs. Body beneath dark brown, with few scales, coarsely but not densely punctured. Legs brown sparsely clothed with clavate hairs. Length (total) .10 inch; 2.5 mm.

This is the smallest species known in our fauna, with the mandibular scar. It may be readily known by its color, the clavate hairs, and the surface almost entirely deprived of scales.

This insect appears to be rare. Occurs in Massachusetts.

TRACHYPHLŒUS Germ.

Trachyphlœus Germ. Ins. Spec. Nov., p. 408.

Rostrum as long as the head, stout, sub-quadrangular, slightly arcuate and with deep transverse impression at base, feebly emarginate in front and with a triangular elevated line in front of which is a smooth space. Scrobes lateral, deep, moderately arcuate and passing directly backward to the eye. Antennæ sub-median, moderate, scape attaining the margin of the thorax, moderately clavate, funicle 7-jointed, first joint longest and robust, second slender, joints 3–7 short, as broad as long, becoming gradually broader outwardly; club oval. Eyes small, round, lateral, coarsely granulated and with a distinct orbital groove. Thorax transversely oval. Elytra oval. Scutellum not visible. Metathoracic side pieces moderate, suture distinct in its entire length. Metasternum short. Intercoxal process of abdomen broad, truncate; second abdominal segment not as long as the two following united, separated from the first by a nearly straight suture. Middle and hind tibiæ not mucronate, anterior tibiæ mucronate and with four or five tooth-like spines around the apical margin. Claws free.

This genus differs by very marked characters from those which precede. In the latter the side pieces of the metasternum are entirely concealed by the elytra. In this the eyes are surrounded by a distinct orbital groove and are small, scarcely prominent and coarsely granulated. The rather deep transverse impression at the base of the rostrum, together with the convexity of the rostrum below this (owing to its being slightly arcuate) give this insect a very peculiar facies.

Digitized by Google

T. asperatus Boh. Sch. Gen. Curc. viii, 1. p. 116.

Form oval, moderately robust, densely covered with a pale ochreous coating indistinctly scaly, variegated on the elytra with brownish spots. Head and rostrum slightly longer than the thorax, the rostrum with a deep, broad, transverse impression at base beneath which the rostrum is strongly convex, surface densely coated, and with clavate scale-like hairs sparsely placed. Thorax transversely oval, nearly twice as long as wide, apex truncate, base feebly arcuate, sides strongly arcuate and very slightly constricted near the tip; surface moderately convex (sculpture indistinct) densely covered with pale brownish coating, median line and sides paler, and with sparsely placed erect, scale-like clavate hairs. Elytra oval, sides very feebly arcuate, apex obtuse, base feebly emarginate, humeri slightly oblique, surface distinctly striate, intervals flat, densely covered with pale ochreous coating variegated with brownish spots and with the clavate scale-like hairs arranged uniseriately on the intervals. Body beneath and legs densely coated, the latter with short bristly hairs. Length .12 inch; 3 mm.

One specimen from the Middle States.

Tribe IV. DIROTOGNATHINI.

Rostrum longer than the head, slightly flattened. Mandibles rather prominent. Mentum very small, trapezoidal, not retracted, maxillæ and ligula entirely exposed. Thorax with feeble ocular lobes. Metasternal side pieces narrow connate with the sternum, with very slight traces of suture.

These few characters serve to distinguish this tribe as represented in our fauna, to which may be added: Mandibles prominent, laminiform at tip, inner edge strongly bi-dentate, outer edge arcuate, with a groove and a scar-like space near the base, apex truncate, scar terminal, small, very narrow and transverse, deciduous pieces short, broader at tip and obliquely truncate. Mentum very small, supported by a distinct peduncle which is rather short. Metasternum rather short.

I am entirely unable to place this tribe in or near any of those indicated by Lacordaire, further than to state that it is *Phanerognath Synmeride* and belongs to the first section of the latter Phalanx.

One genus occurs in our fauna.

DIROTOGNATHUS n. g.

Rostrum longer than the head, slightly broader in front and somewhat flattened, straight, tip truncate. Scrobes lateral feebly arcuate, very indistinctly defined, rapidly wider and evanescent. Antennæ moderate, scape gradually thicker, attaining the posterior margin of the eyes, funicle 7-jointed, first two joints longer, the first longer than the second, 3–7 short broader than long, sub-moniliform, club elongate oval. Eyes broadly oval, coarsely granulated. Thorax with distinct but feeble ocular lobes which are fimbriate. Scutellum invisible. Elytra oval, base feebly emarginate. Metasternum short, side pieces narrow, connate, with scarcely any traces of

Digitized by Google

suture. Intercoxal process broad, truncate, second segment of abdomen much longer than the two following together, separated from the first by a strongly arcuate suture. Tibiæ feebly mucronate, corbels of hind tibiæ open. Body scaly and with short black hairs.

D. sordidus, n. sp.

Form oval, robust, surface moderately densely covered with dark cinereous scales, discolored dark-brown by exudation, and with very short dark-brown hairs. Head and rostrum as long as the thorax, densely scaly, and with few short hairs. Thorax oval, broader than long, slightly narrower in front, sides regularly arcuate from apex to base, apex truncate, base feebly arcuate, disc convex, densely punctured and scaly, scales imbricated, paler in color along the median line and sides, and with very short dark-brown hairs sparsely placed. Elytra broadly oval, broader at base than the thorax, very feebly emarginate at middle, humeri broadly rounded, disc convex, finely striate, striæ not punctured, intervals flat, densely scaly, each interval with two rows of very short, black, semi-erect hairs. Body beneath and legs less densely scaly and very sparsely hairy, tibiæ sparsely fimbriate within. Length .16–.24 inch ; 4–6 mm.

This insect resembles in form and size *Phyxelis rigidus*. The color varies in accordance with the exudation, some being very dark cinereous, others very dark-brown. The males are slightly more elongate than the females, and the sides of the elytra less arcuate.

Occurs very abundantly in the desert regions of Arizona under damp logs, and was also collected by Mr. Crotch at Frot Mojave, California.

DIVISION II.

In this division are contained all those genera in which the mesosternal side pieces are diagonally divided into two nearly equal pieces, the outer of which (epimeron) cuts off the inner (episternum) from any contact with the elytral margin. The metasternal episternum is usually moderately broad, the suture distinct in its entire length, rarely narrow, and in one genus the suture is entirely obliterated. In every case, however, the anterior end of the metasternal episternum is suddenly dilated, causing on one side an emargination of the elytral margin (which is, however, evanescent), while on the inner side an acute triangular process of varying length occupies a space between the mesosternal epimeron and the body of the metasternum.

The antennal scrobes vary in form, position and extent. The mentum is, in all of our genera, at least moderate and visible, excepting *Eudiagogus* and *Coleocerus* where it is small and much retracted, allowing the parts of the mouth to be visible. The beak at tip exhibits two distinct forms. In the one the genæ are rather deeply notched and allow the base of the mandible to be exposed ; in the other there is no emargination or a very feeble one. Accompanying these latter characters we have the upper portion of the beak more prolonged over the mandibles above in the former case,

Digitized by Google

while in the latter the mandibles are always greatly exposed above. A lateral view of the beak will therefore show the tip to be obliquely truncate in those with the emarginate genæ, and squarely truncate in the other case.

The scar of the deciduous mandibular cusp is very distinct in all the genera excepting *Coleocerus*, and is usually on the face of the mandible, although in some genera at the summit of an obtuse process.

The tribes forming this division are shown in the following table :

Mentum moderate, rarely small, never retracted; sub-mentum not notched at middle ; thorax rarely (*Pachnæus*) with feeble ocular lobes. Eyes round.

Thorax fimbriate at the sides behind the eyes. Striæ entire.......... **TANYMECINI.**

Thorax not fimbriate at the sides behind the eyes.

Genæ emarginate behind the mandibles.

Rostrum short, robust; tenth striæ confluent with the ninth ; claws free, except in *Aphrastus*.......... **CYPHINI.**

Genæ not or very feebly emarginate ; tenth striæ free.

Rostrum at least moderately elongate, scrobes long ; claws free ; head not prolonged behind the eyes ; articular surfaces of hind tibiæ cavernous. Mentum large.......... **EXOPHTHALMINI.**

Rostrum rather short, scrobes short ; head prolonged behind the eyes ; claws connate ; articular surfaces of hind tibiæ open. Mentum small.......... **PHYLLOBIINI.**

Mentum small, retracted ; thorax with large ocular lobes. Eyes transversely oval.......... **PROMECOPINI.**

The partial obliteration of the marginal stria occurs in but one tribe, in the others that stria is entire and nearly equally distant from the preceding throughout. The mentum attains the minimum in the last two groups.

Tribe I. TANYMECINI.

Rostrum moderate, sub-angulate, sub-parallel, more or less emarginate at tip and at the sides. Scrobes moderately deep, arcuate, passing beneath the eyes. Antennæ moderate, scape moderately long, usually attaining the hind margin of the eye, sometimes attaining the thorax. Thorax with a short row of bristly hairs behind the eyes (and in *Pachnæus* very feebly lobed). Scutellum distinct. Metasternum moderately long. Second segment of abdomen longer than the third and fourth together, and separated

Digitized by Google

from the first by an arcuate suture. Articular cavities of hind tibia variable. Claws free. As represented in our fauna, this tribe does not differ from the group indicated by Lacordaire, except in the addition of *Pandeletejus*.

Our genera are as follows :

Anterior coxæ contiguous.
- Thorax feebly lobed behind the eyes, (the latter transversely oval, pointed beneath) and bisinuate at base .... **PACHNÆUS.**
- Thorax not lobed, base truncate, eyes round, or longitudinally oval.
  - Anterior femora normal, the tibiæ simple... **TANYMECUS.**
  - Anterior femora much longer and stouter than the others, the tibiæ denticulate within .... **HADROMERUS.**

Anterior coxæ distant.
- Anterior femora larger than the others.. **PANDELETEJUS.**

The articular cavities of the hind tibiæ vary in the genera. They are feebly enclosed in *Pachnæus*, more decidedly in *Tanymecus*, and entirely open in the other two genera. Into this tribe *Polydacris modestus* of Cuba should enter. It has very distinct vibrissæ composed of scales, and the anterior coxæ are separated as in *Pandeletejus*. The tribe as thus constituted is not very homogeneous, and with more genera would divide into well defined groups, each of the above genera constituting a type. With our few genera this appears unnecessary.

PACHNÆUS Sch.

Pachnæus Schönh. Curc. Disp. Meth. p. 121.

Rostrum as long as the head, sub-quadrangular, slightly declivous at tip and emarginate, above obtusely carinate. Scrobes lateral, deep, well defined, narrow, arcuate and passing directly beneath the eyes. Antennæ sub-median, moderate ; scape gradually clavate, attaining the posterior margin of the eyes ; funicle 7-jointed, first two joints longer, the second somewhat longer than the first, joints 3–7 sub-equal ; club oval, pointed. Eyes oval, narrower beneath. Thorax broader than long, narrower in front, apex slightly prolonged, base bisinuate. Scutellum moderate rounded. Elytra oblong oval, each acute at tip, base bisinuate and wider than the thorax, humeri oblique. Intercoxal process broad, arcuate at tip; second abdominal segment as long as the two following, separated from the first by a strongly arcuate suture. Tibiæ finely mucronate at tip. Posterior corbels very feebly cavernous. The slight process at the side of the thorax behind the eyes scarcely warrants the name of ocular lobe. The vibrissæ are, however, well marked. The genæ are extremely feebly emarginate.

P. opalus Oliv. (*Curculio*) Ent. v, 83, p. 339, pl. 24, fig. 345 ; Boh. Sch. Gen. Curc. vi, 1, p. 425.

Digitized by Google

Form oblong, oval, densely covered with pale-blue scales with a faint cupreous lustre. Body winged. Head sparsely punctured, densely scaly. Thorax broader at base than long, narrower in front, sides moderately arcuate, apex faintly lobed, base bisinuate, disc moderately convex, median line feebly impressed; surface densely scaly, median line and sides paler. Elytra densely scaly and with twelve rows of moderate punctures, the ninth somewhat confused, intervals indistinctly biseriately punctulate. Body beneath densely scaly, scales larger and paler than above. Legs densely scaly, tibiæ with short hairs on the inner side. Length .40 inch; 10 mm.

Occurs in Florida, and is not rare.

The base of the elytra is not only bisinuate, but there is also a small dentiform prominence contiguous to the thoracic hind angles. Lacordaire mentions this character for two Cuban species, but not for our own.

P. distans, n. sp.

Form elongate oval, densely covered with pale bluish white scales, with faint cupreous lustre. Head and rostrum slightly longer than the thorax, densely scaly. Rostrum with a fine median elevated line, ending in a frontal puncture. Thorax broader than long, slightly narrower in front, sides feebly arcuate, base feebly bisinuate, disc moderately convex, with large, deep punctures irregularly placed, densely scaly. Scutellum oval, truncate at base. Elytra oblong, sides feebly arcuate, base very feebly bisinuate, humeri not dentiform in front, convex, densely scaly and with twelve rows of coarse and moderately deep punctures, intervals flat, with a single row of minute punctures, each bearing a longer scale. Body beneath and legs densely scaly, and with minute scale-like hairs. Length .32 inch; 8 mm.

Notwithstanding the fact that the elytra are not prominent at the middle of the base of each, I am unwilling to separate this species under a distinct generic name. In the generic table of the *Tanymecides*, Lacordaire assigns strongly cavernous corbels to *Pachnæus*. This is not so in either of our species, the posterior tibiæ having at their tips merely the double row of bristles very feebly separated. The form of the eyes appears to be a character of greater value in the arrangement of the genera of this group, after the form of the tarsi, than any that is made use of by Lacordaire. Too much importance seems to have been given to the form of the base of the elytra, and it will be found that exceptions are met with frequently in many genera.

The species above described was collected at Cedar Keys and Capron, Florida, by Messrs. Schwartz and Hubbard.

TANYMECUS Sch.

Tanymecus Schönh. Curc. Disp. Meth. p. 127.

Rostrum as long as the head, stout, sub-parallel, sub-quadrangular, above flattened, tips either truncate or feebly emarginate. Scrobes deep, feebly arcuate, passing immediately beneath the eyes. Eyes oval, mode-

Digitized by Google

rately prominent, slightly longitudinal. Antennæ anterior moderately long; scape gradually clavate, attaining the posterior margin of the eyes (*confusus*) or the margin of the thorax (*lacæna*); funicle 7-jointed, joints 1–2 longer, sub-equal, 3–7 obconical, gradually shorter, club elongate oval. Thorax sub-cylindrical, longer than wide, with a distinct line of bristly hairs behind the eyes. Scutellum small, triangular. Elytra elongate, oval, wider at base than the thorax, marginal stria distinct. Metasternum long or moderate. Intercoxal process moderate, arcuate in front; second segment of abdomen longer than the two following, separated from the first by a feebly arcuate suture. Anterior and middle tibiæ feebly denticulate within, and with feeble mucro at tip. Articular cavities of hind tibiæ open, ascending and limited by an acute ridge with fine spinules on the posterior edge. Claws free. Surface densely scaly.

The species known to occur in our fanua are two, distinguished as follows:

Rostrum feebly emarginate at tip, not carinate above; scape attaining the margin of the thorax; elytra finely striate with moderate punctures; form dissimilar ♂ and ♀ .... **lacæna.**

Rostrum truncate at tip, very distinctly but finely carinate above; scape attaining the posterior margin of the eyes; elytra similar in form in the sexes and with rows of large deep punctures.......... **confertus.**

T. **lacæna** Hbst. (*Curculio*) Käfer vii, p. 35, pl. 100, fig. 10; Fahrs. Sch. Gen. Curc. vi, 1, p. 232; *leucophæus* ♂ Gyll. loc. cit. ii, p. 78; *canescens* ♀ Gyll. loc. cit. p. 85.

Form oblong, oval, surface densely covered with cinereous scales. Head and rostrum nearly as long as the thorax, moderately, densely punctured, and rather sparsely clothed with rather elongate scales. Thorax sub-cylindrical, slightly longer than wide, slightly narrower in front, sides moderately arcuate, disc moderately convex, densely punctured, moderately, densely scaly, scales cinereous, with slight cupreous tinge, a badly-defined darker line at the sides. Elytra oblong, oval, (longer and slightly dehiscent at tip in male) sides feebly arcuate and gradually attenuate to tip, humeri obtusely rounded; disc moderately convex, feebly striate, striæ with moderate punctures, not closely placed, surface moderately densely covered with cinereous scales, each alternate interval at base slightly darker. Body beneath and legs moderately densely scaly. Length .32 ♀ - 36 ♂; 8–9 mm.

Occurs in Georgia and Florida.

T. **confertus** Gyll. Sch. Gen. Curc. ii, p. 88; *confusus* Say, Descr. Curc. p. 9; Am. Ent. 1, p. 269.

Head and rostrum nearly as long as the thorax, sparsely scaly, more densely over the eyes, surface densely punctured, rostrum feebly sub-carinate. Thorax cylindrical, slightly narrowed in front, sides in front

Digitized by Google

slightly arcuate, posteriorly sub-parallel, disc moderately convex, densely punctured, sparsely scaly. Scutellum white. Elytra oblong, sides sub-parallel, disc moderately convex, obsoletely striate and with coarse, deep, moderately closely placed punctures, gradually becoming smaller to tip; surface moderately, densely covered with cinereous scales, irregularly mottled with brown. Body beneath and legs moderately densely scaly. Length .20–.28 inch; 5–7 mm.

The thorax has a median and lateral space partially deprived of scales, giving the surface a vittate appearance. In specimens from the Southern States, the scales become more or less cupreous, and the specimens are usually larger.

Occurs everywhere east of the Rocky Mountains.

HADROMERUS Sch.

Hadromerus Schönh. Curc. Disp. Meth. p. 136.

Rostrum as long and nearly as wide as the head, sub-quadrangular, above flat, finely canaliculate, emarginate at tip and with a narrow triangular smooth space, deeply triangularly notched at the sides. Scrobes moderately deep, well defined, arcuate, passing downwards at a distance from the eyes. Antennæ moderate, scape gradually clavate, attaining nearly the posterior margin of the eye; funicle 7-jointed, joints 1–2 elongate, 3–7 obconical; club elongate, oval. Eyes large, round, moderately prominent. Thorax sub-globose, truncate at apex and base. Scutellum triangular. Elytra wider at base than the thorax, moderately elongate, parallel, obtusely acuminate posteriorly; humeri moderately prominent. Metasternum moderately elongate. Intercoxal process broad, oval at tip; second abdominal segment longer than the two following together, separated from the first by a moderately arcuate suture. Anterior legs longer, the femora stouter than the others, the tibiæ of the same pair denticulate within, and obtusely mucronate. Articular surface of hind tibiæ open, glabrous. Claws free. Body densely scaly.

H. opalinus, n. sp.

Form moderately elongate, densely covered with bright-blue scales with greenish and golden reflections, and with short, fine, yellowish setæ very sparsely placed. Head and rostrum (and mandibles) densely scaly, sparsely punctured, together as long as the thorax. Thorax sub-globose, truncate at apex and base, slightly broader than long, surface densely scaly, sparsely punctate. Elytra oblong, parallel, base feebly emarginate, surface densely scaly, finely striate, striæ finely and closely punctured, intervals flat, and with a single series of setæ on each. Body beneath as above; tibiæ rufous, femora darker, anterior femora piceous. Length .32 inch; 8 mm.

This species is the most brilliant and more decidedly tropical in its appearance of any in the family in our fauna.

Occurs in Arizona. C. V. Riley.

Digitized by Google

PANDELETEJUS Sch.

Pandeleteius Schönh. Curc. ii, p. 129.

Rostrum not as long as the head, slightly compressed, quadrangular, slightly grooved above, tip entire and without smooth space or feebly emarginate with small smooth space. Vertex feebly convex. Scrobes lateral, moderately deep, well defined, slightly arcuate and passing immediately beneath the eyes. Eyes small, slightly oval. Antennæ moderate, slender, scape gradually clavate, attaining nearly the posterior margin of the eyes; funicle with joints 1–2 elongate, 3–7 very short, moniliform; club elongate oval. Thorax cylindrical, broader than long, with sides arcuate, apex obliquely, base squarely truncate. Scutellum small, triangular. Elytra wider at base than the thorax, humeri moderately prominent, form oblong. Intercoxal process moderately broad, oval at tip. Second abdominal segment longer than the two following together, separated from the first by a feebly arcuate suture. Anterior legs longer than the others, their femora stouter, and their tibiæ denticulate within. Articular surface of hind tibiæ terminal, not cavernous. Body winged, surface densely scaly.

Lacordaire places this genus among the Naupactides, having entirely overlooked the fimbriæ at the side of the thorax behind the eyes. No mention is made of the separation of the anterior coxæ. As has been already mentioned *Polydœris* is closely related to *Pandeletejus;* the anterior coxæ are in it also separated, and the sides of the thorax have distinct vibrissæ composed, however, of scales. I think these two genera should make but one.

Two species occur in our fauna:

Tip of rostrum entire, without smooth space.................. .. **hilaris.**
Tip of rostrum emarginate, with smooth space................ **cinereus.**

These two differ also in the form of the thorax. In the latter, the thorax is dilated only at the middle, so that the cylindrical portions in front and behind the dilatation are equal. In the former, the dilatation is pyriform, and the anterior narrower part much shorter than the posterior.

P. hilaris Hbst. (*Curculio*) Käfer, vii, p. 58, pl. 100, fig. 7–8; (*Hadromerus*) Say, Descr. Curc. p. 10; *pauperculus* Gyll. Schönh. Gen. Curc. ii, p. 130.

Form moderately elongate, densely covered with cinereous scales, disc of elytra darker and with an oblique median fascia entering the darker space. Rostrum nearly squarely truncate at tip, and without smooth space, surface densely scaly, sparsely punctured. Thorax longer than wide, cylindrical, sides dilated, and broader behind the middle, anteriorly with a cylindrical constriction, posteriorly with shorter constriction; disc moderately convex, densely and coarsely punctured, densely covered with cinereous scales, a broad median line and the sides darker. Elytra truncate at base, oblong, broadest behind the middle; ten-striate, striæ closely punctured, intervals slightly convex, surface densely scaly. Body beneath

Digitized by Google

densely scaly, scales with pearly lustre. Legs with cinereous scales, indistinctly annulate with darker; tibiæ slightly hairy within. Length .16–.20 inch. 4–5 mm.

This species occurs rather abundantly from New York to Texas.

P. cinereus, n. sp.

This species resembles the preceding in form and color. It is, however, generally smaller, paler in color and differs especially in the following manner:

Rostrum distinctly emarginate at tip and with narrow crescentic smooth space. Thorax cylindrical, dilated at middle, on both sides of which it is equally cylindrically constricted. Body beneath sparsely covered with paler scales, without lustre. Length .14–.18 inch; 3.5–4.5 mm.

Occurs rather abundantly in Texas.

The sexual differences are not well marked. The anterior coxæ appear to be more widely distant in the male than in the female, and in the second species the same coxæ are more distant sex by sex than in the preceding.

Tribe II. CYPHINI.

Rostrum robust, deeply emarginate at tip and sides. Scrobes variable. Antennæ moderate, second joint of funicle longer than the first, rarely (*Aphrastus*) equal to it. Thorax without ocular lobes or fimbriæ. Claws free except in *Aphrastus*. Articular surface of hind tibiæ internal and cavernous except in *Aphrastus*, usually glabrous, rarely scaly. Elytra with the outer stria confluent with the next inner at one-third from the base. Metasternum moderately long.

The rostrum is always acutely emarginate in front and at the sides, and in all our genera there is a fine median groove. The supports of the deciduous pieces are usually very prominent, and the deciduous pieces are (as far as seen) elongate, glabrous, falciform and acute at tip.

The following groups may be recognized:

Claws free; articular surfaces of hind tibiæ cavernous.
- Elytra wider at base than the thorax, humeri prominent.... **Cyphi.**
- Elytra oval, not wider at base than the thorax, humeri rounded.. **Artipi.**

Claws connate; articular surfaces of hind tibiæ not cavernous.
- Elytra oval, humeri rounded, body apterous.................... **Aphrasti.**

Group I. Cyphi.

Humeri prominent, elytra wider at base, wider than the thorax. Scutellum distinct. Body winged.

Our genera are few in number and may be distinguished as follows:

Articular surface of hind tibiæ scaly. Scape passing the eyes.. **COMPSUS.**

Articular surface of hind tibiæ glabrous. Scape not passing the eyes.

Digitized by Google

Scape moderate, scrobes long, passing beneath the eyes. Scutellum small, triangular............... **CYPHUS.**
Scape short, stout, scrobes short, suddenly arcuate. Scutellum rather large, oval...............**BRACHYSTYLUS.**

Brachystylus has been placed by Lacordaire among the *Otiorhynchini*, but the entire structure is that of the *Cyphini*, notwithstanding the slight irregularity in the form of the scrobes.

COMPSUS Sch.

Compsus Schönh. Curc. Disp. Meth., p. 109.

Rostrum as long as the head, slightly dilated at tip which is deeply emarginate above and at the sides, above finely sulcate and with a broad triangular impression at apex. Supports of deciduous pieces prominent. Scrobes deep, shallower behind, moderately arcuate and terminating above the inferior edge of the eye. Eyes oval, sub-acute beneath. Antennæ moderately long, sub-apical, scape long, passing the eyes behind, feebly clavate; funicle 7-jointed, joints 1–2 longer, the second longer than the first, joints 3–7 nearly cylindrical, feebly decreasing in length; club elongate oval. Thorax broader than long, narrower in front, truncate at apex, bisinuate at base. Scutellum rounded. Elytra oblong, wider than the thorax, humeri prominent. Anterior tibiæ moderately, middle tibiæ feebly mucronate; articular surface of hind tibiæ cavernous, densely scaly. Intercoxal process rounded at tip, broad. Second abdominal segment longer than the third and fourth together, and separated from the first by a strongly arcuate suture. Body densely scaly.

C. auricephalus Say (*Curculio*), Journ. Acad., 1823, p. 310; Boh. Sch. Gen. Curc. i, p. 645; *auripes* Sch. Gen. Curc. vi, 1, p. 183.

Form elongate, somewhat navicular, surface densely covered with scales varying in color from white to greenish-white. Head and rostrum longer than the thorax, sparsely punctured, densely covered with scales varying in color from white to pale cupreous. Antennæ scaly. Thorax wider at base than long, apex truncate, base bisinuate, sides moderately arcuate and converging in front, disc moderately convex with broad median groove wider behind, limited on each side by an obtuse ridge, surface sparsely punctured, densely scaly. Elytra more than twice as wide as long, slightly wider behind the middle, and feebly acuminate at tip, disc moderately convex, feebly striate, striæ with large distant punctures, alternate intervals sub-costiform, surface densely scaly and with very short scale-like hairs on the costiform intervals. Body beneath and legs densely scaly and with short setæ. Length .36–.48 inch; 9–12 mm.

The color of the scales covering the body varies from white to pale green. In the latter case the upper side of the head and the outer side of the legs are pale cupreous.

Occurs rather abundantly from Georgia to Mexico, also to the north in Colorado.

Digitized by Google

CYPHUS Germ.

Cyphus Germ. Ins. Spec. nov., p. 427.

Rostrum not longer than the head, robust, quadrangular, slightly narrower in front, tip and genæ deeply emarginate, above sulcate. Scrobes lateral deep, well-defined, arcuate and passing directly beneath the eyes. Eyes round, moderately prominent, finely granulated. Antennæ moderate; scape feebly clavate, attaining the middle of the eye; funicle 7-jointed, joint 2 longer than the first, 3–7 sub-equal, slightly obconical; club elongate oval. Thorax broader than long, narrower in front, apex truncate, base bisinuate. Scutellum small triangular. Elytra wider at base than the thorax, humeri moderately prominent, rather more than twice as long as wide, and at apex slightly acuminate. Metasternum moderately long. Intercoxal process broad, sub-truncate. Second abdominal segment as long as the two following united, separated from the first by a feebly arcuate suture. Articular surface of hind tibiæ enclosed (cavernous), and ascending. Anterior and middle tibiæ feebly mucronate. Body densely scaly.

The middle and hind tibiæ have the articular surfaces ascending one-third the length of the tibiæ, the edge being sharp and fimbriate with bristly hairs. The surfaces are however entirely glabrous. In addition to the differences in the number of the dorsal segments of the sexes, the females may be known by an additional character. On each side of the last segment, is a short, rather deeply-impressed line, parallel with the lateral margin and about one-fourth the width of the segment from the side, beginning at the last ventral suture and extending nearly half the length of the segment. The last ventral of the male is not so marked, and is rather longer than in the female.

Two species occur in our fauna.

Thorax abruptly narrowed in front, sides behind the front angles strongly arcuate. Anteriorly rather abruptly truncate .... **lautus.**

Thorax gradually narrowed from base, sides feebly arcuate. Apex very obliquely truncate, with the upper margin decidedly prolonged over the occiput........................ **placidus.**

The differences between these two species are more appreciable in nature than expressible by words. The punctures of the striæ are much finer in *placidus* than in *lautus*.

C. lautus Lec. (*Tanymecus*) Proc. Acad., 1854, p. 85.

Form oblong, robust, densely scaly. Head and rostrum slightly longer than the thorax. Rostrum trisulcate, median sulcus moderately deep and extending to the occiput, lateral sulci short, slightly oblique, surface sparsely punctured, moderately densely scaly. Thorax broader than long, subquadrate, sides in front strongly arcuate and rather suddenly narrowed, slightly sinuate before the hind angles, apex truncate, base bisinuate, hind angles slightly laminiform; disc moderately convex, a fine median line ending in a broad shallow fossa near the base, a short linear basal impres-

Digitized by Google

sion on each side near the hind angles; surface coarsely punctured with fine punctures intermixed, moderately densely scaly. Elytra wider at base than the thorax, and three times as long, humeri slightly oblique, sides parallel, apex slightly prolonged; disc moderately convex finely striate, striæ moderately coarsely punctured, intervals flat; surface moderately densely scaly, scales cinereous with a transverse fuscous spot on each elytron slightly in front of the middle and another smaller near the declivity. Body beneath moderately densely scaly; legs densely scaly, sparsely pilose, middle and hind femora with a fuscous spot near the tip. Body winged. Length .36–.52 inch; 9–13 mm.

var. lautus. Elytra moderately densely scaly, scales cinereous, with two fuscous spots on each elytron, the anterior slightly in front of the middle and formed of short lines of fuscous scales on the intervals 2 to 5 surrounded with paler cinereous scales, a similar spot on the beginning of the declivity composed of three short lines on intervals 2–3–4.

var. ————. Elytra uniformly covered with nearly white scales moderately densely placed.

This species occurs in Arizona, and has been distributed under the unpublished name *Brachythysus lautus.*

C. placidus, n. sp.

Oblong, more slender than *lautus.* Head somewhat narrower, median sulcus broader at middle. Thorax scarcely wider than long, gradually narrower from base to apex, sides feebly arcuate; apex obliquely truncate slightly prolonged over the head, base bisinuate, hind angles slightly laminiform; disc with broad shallow median fovea, and a feeble impression on each side near the base, surface sparsely punctured with finer punctures intermixed, very densely scaly especially in the median fovea. Elytra similar in form to *lautus* but rather longer in proportion to their width; disc moderately convex, finely striate, and with rather fine punctures rather distantly placed; surface very densely scaly. Body beneath very densely scaly and sparsely hairy. Legs densely scaly, tibiæ pilose. Length .48–.52 inch; 12–13 mm.

The two specimens before me, both females, vary in color. The larger is pale greenish-white, the other simply white. The scales are so densely placed as to entirely conceal the surface color. In this respect they differ notably from the preceding species. The more striking differences have already been pointed out.

Two specimens. Arizona.

BRACHYSTYLUS Sch.

Brachystylus Schönh. Gen. Curc. viii, 2, p. 433.

Rostrum horizontal, nearly as long and as broad as the head, deeply emarginate at tip (with narrow smooth space) and at the sides, above flat and with a fine median groove. Scrobes short, narrow in front, their lower border suddenly flexed and directed downwards. Eyes round, moderately prominent. Antennæ short, scaly; scape short, robust, obconical, passing

Digitized by Google

slightly beyond the middle of the eye ; funicle 7-jointed, first joint short robust, second longer, joints 3–7 cylindrical, sub-equal ; club oval. Thorax conical, truncate at apex, feebly bisinuate at base. Scutellum oval, narrower at base. Elytra wider than the thorax, slightly wider behind the middle, apex sub-acuminate. Metasternum elongate. Intercoxal process moderate, oval at tip. Second abdominal segment very much longer than the two following combined, separated from the first by a strongly arcuate suture. Anterior and middle tibiæ mucronate ; articular surface of hind tibiæ enclosed (cavernous). Claws very small. Body densely scaly.

The affinities of this genus are so plainly with *Cyphus* that it is rather singular they should have been overlooked by Lacordaire.

B. acutus Say (*Chlorophanus*), Journ. Acad., 1824, p. 310 ; Curc. N. A., p. 7 ; Am. Ent. i, p. 266 ; Boh. Sch. Gen. Curc. viii, 2, p. 434.

Form oblong. Head and rostrum not as long as the thorax, sparsely punctured, very densely scaly. Thorax conical, slightly longer than wide at base, apex truncate, base feebly bisinuate, sides very feebly arcuate at middle ; disc slightly flattened, sparsely punctured, densely scaly. Elytra oblong, sub-acuminate at tip, base broader than the thorax, humeri prominent, sides very feebly arcuate, slightly divergent ; surface feebly striate, striæ with coarse punctures, intervals feebly and alternately more convex, densely scaly. Body beneath and legs densely scaly. Length .36 inch ; 9 mm.

The color of the scales covering the body is earthy brown, the tip of the elytra much paler and with a broad post-median dark brown fascia bordered anteriorly with paler. The tibiæ of both sexes are fimbriate within. The last abdominal segment is acutely triangular in the female, rounded in the male.

Occurs in Pennsylvania, Georgia, and Kentucky.

Group II. Artipi.

Elytra oval or oblong, not wider at base than the thorax, humeri oblique. or broadly rounded. Scutellum distinct. Antennæ long, scape passing the eyes behind. Articular surfaces of hind tibiæ cavernous. Rostrum rather deeply notched behind the base of the mandibles.

The essential difference between this group and the preceding is found in the form of the elytra. The antennæ (especially the scape), are longer and more slender. The rostrum varies in form and is usually short, stout, flattened above and deeply notched at tip. In one genus however the rostrum is decidedly Periteloid with less divergent alæ. All the genera excepting *Artipus* have the anterior tibiæ denticulate within.

Our genera are as follows :

Rostrum short, stout. Scrobes linear in front.

  Articular surface of hind tibiæ scaly ; anterior tibiæ not denticulate within........................ **ARTIPUS.**

  Articular surfaces of hind tibiæ glabrous ; anterior tibiæ more or less denticulate within.

Digitized by Google

Articular surfaces of hind tibiæ very feebly or not cavernous; tips of hind tibiæ with, at most, a double row of fimbriæ.................. **ARAMIGUS.**

Articular surfaces of hind tibiæ, strongly cavernous; tips of hind tibiæ with oval scaly space. **PHACEPHOLIS.**

Rostrum moderately elongate. Scrobes cavernous in front.

Articular surfaces of hind tibiæ sparsely scaly... **ACHRASTENUS.**

Artipus has a form somewhat resembling *Cyphus*, without however having the humeri prominent. The next two genera, especially *Aramigus* resemble an elongate *Strophosomus*. *Achrastenus* resembles *Peritelus*.

ARTIPUS Sch.

Artipus Schönh. Curc. Disp. Meth., p. 133.

Rostrum not longer than the head, robust, angles rounded, finely canaliculate above, and with a very shallow impression near the apex crossed by a feeble transverse ridge between the insertion of the antennæ, tip triangularly emarginate, and with a narrow smooth space; genæ deeply notched. Scrobes narrow in front and moderately deep, gradually broader and evanescent behind, the lower border strongly arcuate and directed inferiorly. Eyes oval, slightly longitudinal, moderately prominent. Antennæ subterminal, moderately long; scape feebly clavate and attaining the thorax; funicle 7-jointed, 1–2 longer, sub-equal, 3–7 shorter sub-equal; club oblong oval. Thorax cylindrical, slightly narrowed in front. Scutellum moderate, oval. Elytra oval, nearly twice as long as wide, not wider than the thorax, base sub-truncate, humeri feebly oblique. Metasternum moderately long. Intercoxal process of abdomen broad, rounded at tip; second segment longer than the two following, separated from the first by a strongly arcuate suture. Anterior and middle tibiæ mucronate. Articular surfaces of hind tibiæ scaly. Claws free. Body winged, surface densely scaly.

Not only are the hind tibiæ scaly at tip, but also the articular surfaces of the other tibiæ are partially encroached upon by scales, and those of the hind tibiæ are very feebly cavernous.

A. floridanus, n. sp.

Form oblong, surface densely clothed with white scales, varying to pale greenish blue with cupreous lustre. Head and rostrum not as long as the thorax, sparsely punctured and densely scaly. Thorax as wide as long, cylindrical, slightly narrower in front, sides very slightly arcuate, apex and base truncate, disc moderately convex, median line moderately impressed, interrupted, surface unevenly punctured, densely scaly. Elytra nearly twice as wide as long, broadest behind the middle, sides feebly arcuate, base sub-truncate, disc moderately convex, feebly striate, striæ with moderate but very unequal punctures not very closely placed, intervals nearly flat, each with two rows of short scale-like hairs, surface densely scaly, the larger punctures surrounded by a darker area. Body beneath and legs densely scaly and sparsely hairy. Length .24 inch; 6 mm.

Digitized by Google

On examining the anterior tibiæ with rather high power, minute denticulations may be detected. This species resembles one from Cuba (sent by Professor Poey, without name) which has the elytral intervals more convex, the punctures of the striæ, larger, more regular and closer and the thorax more densely punctured.

Several specimens from Key West, Florida.

ARAMIGUS n. g.

Rostrum slightly narrower than the head, very little longer and somewhat narrowed in front, tip triangularly emarginate, genæ deeply notched. base of mandibles exposed, above finely grooved. Scrobes lateral, narrow in front, sides slightly divergent behind, arcuate and directed beneath the eyes. Eyes oval, longitudinal and prominent. Antennæ sub-median, long, slender; scape long, slender, rather suddenly clavate, attaining the thorax; funicle 7-jointed, longer than the scape, joints 1–2 longer, the second much longer than the first, joints 3–7 moderately long, sub-equal; club elongate oval. Thorax cylindrical, sides feebly arcuate. Scutellum either small or indistinct. Elytra oval, not wider than the thorax and truncate at base. Metasternum moderate. Intercoxal process of abdomen broad, truncate; second segment of abdomen longer than the two following united, separated from the first by an arcuate suture. Anterior femora stouter than the others, their tibiæ denticulate within and mucronate at tip. Hind tibiæ with the posterior edge at tip acute, margined with densely placed spinulose hairs. Articular cavities not or extremely feebly cavernous and ascending the tibiæ. Claws moderate, free. Body densely scaly.

This genus would probably belong to Lacordaire's *Brachyderides* and its position near *Eurymetopus*. The resemblance of the species to *Strophosomus* has already been noticed, and it may be remarked that *Eurymetopus* has also been so compared. I find, however, differences of sufficient importance in the descriptions to convince me that our species cannot be referred to any known genus.

Two species are known in our fauna:

Denticulation of anterior tibiæ indistinct; surface densely scaly.. **tesselatus.**
Denticulation very distinct; surface not densely covered... **Fulleri.**

The humeri of the first species are rectangular and slightly prominent anteriorly and in the latter obliterated. The articular surfaces of the middle tibiæ ascend nearly as much as in the hind tibiæ in *tesselatus*, and are not at all ascendent in *Fulleri*.

A. tesselatus Say, (*Liparus*) Journ. Acad. 1824, p. 318; *Strophosomus?* id. Mels. Cat. p. 97; *Ophryastes* id. Catalogus. Gemm. and Harold, p. 2317.

Form oblong, oval, surface densely scaly, of variable color. Head and rostrum as long as the thorax, densely scaly, except at apex, sparsely punctured. Thorax cylindrical, slightly narrowed in front, slightly broader than long, sides feebly arcuate, apex and base truncate, disc mode

Digitized by Google

rately convex, finely punctured, densely scaly. Elytra regularly oval, slightly acuminate posteriorly, sides regularly arcuate, base sub-truncate, humeri slightly prominent anteriorly; disc convex, feebly striate, striæ not closely punctured, intervals flat. The seventh slightly elevated at humerus, surface very densely scaly and with numerous very short, semi-erect, scale like hairs. Body beneath densely scaly, sparsely setose, legs densely scaly, tibiæ sparsely pilose. Length .20–.30 inch; 5–7.5 mm.

This species presents two varieties.

var. tesselatus Say. Head and rostrum with earthy-brown scales, paler around the eye and beneath. Thorax similar in color, with a narrow pale line at the sides and a broader pale line on each side of a broad median brownish space. Elytra earthy-brown, on each side of suture obscurely variegated with paler mottlings and a small pale humeral line, and a narrow space at the side of the tip.

These specimens are found in Southern Illinois.

var. pallidus. This variety is of somewhat larger size than the preceding, the scales covering the surface are pale-greenish white, and with barely perceptible darker spaces arranged in a manner similar to the preceding variety.

This variety occurs from Kansas to Texas.

Both varieties have the lateral striæ of the elytra more distinctly impressed than those of the disc.

A specimen of the latter variety was submitted to Mr. Pascoe, who was of the opinion that it might be identical with "*Sitona durius* Germ." *

A. Fulleri, n. sp.

Form oblong oval, surface not densely clothed with dark-brown scales. Head and rostrum longer than the thorax, densely punctured, sparsely scaly. Rostrum with feeble ridge on each side from the tip nearly to the eyes. Thorax cylindrical, apex and base equal and truncate, very slightly wider than long, sides feebly arcuate, a fine median line, disc moderately convex, densely punctured, sparsely scaly. Elytra regularly oval, humeri entirely obliterated, base sub-truncate, surface indistinctly striate, and with rows of large, moderately closely placed punctures, intervals flat, not densely scaly, and with very minute sub-erect hairs; scales dark-brown, a whitish or paler stripe beginning at the humerus, passing along the lateral margin, ending in a short oblique fascia at the middle of the elytra. Body beneath sparsely scaly. Legs with scale-like hairs. Ante-

* Since the above was written the following note has been received from Mr. H. Jekel.

"*Liparus tesselatus* Say. It is a *Naupactus* sensu Sch., so very allied to the female of *N. durius*, Germ., from Brazil, that, should not the size be a third larger, and the habitat so distant I would have regarded them as identical * * *. For that group of *Naupacti* I have created the genus AOMOPACTUS."

I am not aware that this genus suggested by Mr. Jekel has been described. The remarks apply especially to the variety *pallidus*, *Fulleri* being more nearly allied to *ovulum* Jek., from the Pampas, Mendoza.

Digitized by Google

rior tibiæ rather strongly denticulate within, articular surfaces of middle tibiæ not ascendent. Length .26 inch ; 6.5 mm.

The form of this species is not unlike the preceding. The elytra are, however, narrower between the humeri and the thorax, not broader at base.

This species is dedicated to my friend And. S. Fuller, to whom I am indebted for this and many other species.

Occurs from New Jersey to Montana.

PHACEPHOLIS n. g.

Rostrum longer than the head, slightly cuneiform, sub-quadrangular, flattened above, and with a fine median groove, tip triangularly emarginate. Scrobes narrow, moderately deep, well defined, slightly broader behind and passing immediately beneath the eyes. Eyes round, moderately prominent. Antennæ sub-median, long, slender; scape nearly attaining the margin of the thorax, slender, rather suddenly clavate at tip; funicle 7-jointed, longer than the scape, joints 1–2 long, the second much longer than the first, 3–7 sub-equal, 7 obconical; club elongate oval. Thorax narrower in front, sides moderately arcuate, base truncate. Scutellum triangular. Elytra oval, feebly emarginate at base, humeri rounded. Intercoxal process of abdomen broad, truncate at tip; second segment longer than the two following, separated from the first by a strongly arcuate suture. Anterior tibiæ mucronate at tip, rather strongly denticulate within. Hind tibiæ truncate at tip with oval, densely scaly space, articular surfaces cavernous, not ascending, Body densely scaly and pilose. Claws free.

This genus resembles the preceding in form and differs in the structure of the hind tibiæ and the more distinct scutellum. The mandibles are moderately prominent, exposed at base by the emargination of the genæ, their surface scaly. The supports of the deciduous pieces are prominent, and obliquely truncate. The deciduous pieces are long, slightly curved and glabrous. I cannot satisfy myself that this genus should enter any of the genera proposed by Lacordaire.

Three species occur in this genus which differ in the form of the thorax as follows :

Thorax squarely truncate ; eyes not prominent...... .... **elegans.**
Thorax obliquely truncate ; eyes prominent ; head slightly
constricted behind the eyes.................................... **obscura.**
Thorax obliquely truncate and slightly prolonged over the
head ; eyes feebly prominent.................................. **candida.**

The first species has the thorax squarely truncate, so that it is no longer on the dorsal than on the sternal side. The eyes are not prominent, and the scales, although variable, of a metallic or pearly lustre. In the second species the head is broadly constricted behind the eyes, the latter prominent, and the thorax is obliquely truncate, but not sub-lobed in front, the scales of the surface are luteous without lustre, with darker spaces on the

Digitized by Google

thorax and elytra. The third species is larger than the other two, the scales pale cinereous or nearly white. The thorax is obliquely truncate and somewhat lobed in front and slightly prolonged over the occiput.

P. elegans, n. sp.*

Oblong oval, moderately robust, surface densely covered with brilliant metallic blue scales, varying to pearly and cupreous. Head and rostrum as long as the thorax, sparsely punctured, densely scaly, with sparsely placed, short, erect hairs, median line finely impressed. Thorax broader than long, slightly narrower in front, sides feebly arcuate, apex and base truncate, hind angles slightly laminiform; disc moderately convex, moderately coarsely punctured, densely covered with round scales and with sparsely placed, very short, erect hairs. Elytra oval, slightly acuminate posteriorly, sides feebly arcuate, surface striate, stria with moderate but not closely placed punctures, intervals flat, densely scaly, and with two or three rows of short, erect, white hairs. Body beneath rather sparsely scaly and setose. Legs sparsely scaly, tibiæ sparsely hairy. Length .20–.28 inch; 5–7 mm.

The thorax at base is very feebly bisinuate, but to such a small degree that I have preferred to say truncate. The vestiture varies in color greatly and is always paler beneath than above. Resembles considerably the figure given by Duval of *Eusomus ovulum*.

Occurs from Kansas to Texas. The specimens from the latter region are more brilliant.

P. obscura, n. sp.

Form oval, robust, surface densely covered with scales and short erect hairs. Head and rostrum nearly as long as the thorax, head feebly constricted behind the eyes, sparsely punctured, densely covered with brownish scales, above each eye a paler space, head and rostrum beneath nearly white. Thorax oval, slightly longer than wide at base, apex narrower and obliquely truncate, sides moderately arcuate and gradually converging from base to apex; disc moderately convex, punctured, median line feeble, densely covered with brownish scales, a broad paler line on each side of middle, and a narrower line at the sides. Elytra regularly oval, scarcely attenuate at apex, disc convex, striate, striæ with moderate, not closely placed punctures, intervals feebly convex at the sides, surface densely covered with luteous and brownish scales in irregular longitudinal stripes, each interval with one or two rows of moderately long erect white hairs. Body beneath and legs moderately densely scaly and paler than the upper surface. Length .22–.28 inch; 5.5–7 mm.

This species has much more the aspect of *Strophosomus* than any other in our fauna. The eyes are much more prominent than the other two species, and in this resembles the above genus.

Two specimens, Texas.

* "*Naupactus* of the group *stupidus*, *nobilis* and *crinitus*, belonging to my genus *Pantopactus*." Jekel.

Digitized by Google

P. candida, n. sp.

Form oblong, surface densely covered with nearly white scales. Head and rostrum as long as the thorax, median groove fine, attaining the occiput, surface sparsely punctured, densely scaly and with sparsely placed, very short, white hairs. Eyes feebly prominent. Thorax as long as wide at base, slightly narrowed in front, sides moderately arcuate, base feebly bisinuate, apex obliquely truncate and slightly lobed in front and feebly sinuate behind the eyes; disc convex, median line feebly impressed, a slight impression within each hind angle, surface granular, densely scaly and with very sparse hairs. Elytra regularly oval, base feebly emarginate at middle, humeri very obtuse, sides moderately arcuate, disc convex, striate, striæ with elongate, moderately closely placed punctures, intervals moderately convex, densely scaly and with very short white hairs. Body beneath and legs densely scaly, tibiæ sparsely fimbriate. Anterior and middle tibiæ denticulate within and mucronate at tip, more strongly in the anterior. Length .32 inch; 8 mm.

This species is the largest of the three at present known, and differs abundantly from either of those just described, as shown in the synoptic table and the remarks following.

Two specimens, Colorado and Kansas.

ACHRASTENUS n. g.

Rostrum nearly horizontal, longer and narrower than the head, parallel, slightly flattened, very feebly emarginate in front, distinctly notched behind the mandibles, above with a fine median groove. Head very slightly constricted behind the eyes. Scrobes widely open from above; cavernous in front, very shallow posteriorly, slightly arcuate and directed towards the eyes. Eyes oval, slightly truncate in front and pointed beneath. Antennæ moderately long, slightly scaly; scape feebly clavate, nearly attaining the thorax; funicle not longer than the scape, 7-jointed; joints 1–2 longer, the second slightly longer than the first, joints 3–7 slightly obconical, sub-equal; club oval. Thorax cylindrical, narrower in front, apex obliquely truncate, base very slightly arcuate. Scutellum moderate, oval. Elytra oval, base moderately emarginate, humeri oblique, feebly prominent. Intercoxal process moderate, oval at tip. Second segment of abdomen longer than the two following united, separated from the first by a strongly arcuate suture. Anterior and middle tibiæ feebly mucronate; articular surfaces of hind tibiæ feebly cavernous, sparsely scaly. Claws free. Body densely scaly.

According to the system adopted by Lacordaire, this genus belongs to the *Eustylides* of the *Otiorhynchides*. The construction of the sternal side pieces excludes it at once from the latter tribe. The scrobes, and in fact the structure of the rostrum generally, are very nearly that of *Peritelus*, and its appearance, shape and coloration do not differ remarkably from *P. griseus* of Europe. I prefer, however, to place the genus here as a degraded member of the tribe with affinities with the *Otiorhynchini*. In-

Digitized by Google

stances are numerous in every tribe of genera which have characters of other tribes, of more or less distant position, in addition to the distinctive characters of the tribe to which they belong. In addition to the above generic characters the outer elytral striæ have the characteristic form of the other members of the tribe, the outer stria joins the next inner one third from the base. This is not known in our Otiorhynchini.

A. griseus, n. sp.

Form oblong oval, gradually narrower anteriorly, surface densely covered with greyish scales, irregularly variegated on the elytra with darker spots. Head and rostrum as long as the thorax; a fine medium line extending to the vertex, surface moderately densely scaly. Thorax cylindrical, somewhat narrower in front, slightly longer than wide; apex truncate, base feebly arcuate, sides moderately arcuate, disc convex, moderately densely, but not coarsely, punctured. Elytra oval, one and a half times longer than wide, conjointly emarginate, humeri oblique, feebly prominent, sides moderately arcuate and gradually divergent, apex feebly prolonged; disc moderately convex, feebly striate, striæ with moderate, not closely placed punctures, intervals feebly convex, surface densely scaly, each interval with a single row of minute setæ. Body beneath and legs densely scaly, and sparsely setose. Anterior tibiæ with distant denticulations within; at tip (also the middle tibiæ) finely mucronate. Length .20–.24 inch; 5–6 mm.

In many of the specimens the intervals slightly alternate in the degree of their convexity.

Occurs in Texas.

Group III. Aphrasti.

Head broader behind the eyes; scrobes slightly visible from above, deep, directed toward the eyes but not reaching them, gradually broader behind. Antennæ moderate. Elytra slightly wider at base than the thorax, humeri obtuse. Scutellum distinct. Articular surface of hind tibiæ not cavernous, slightly scaly. Claws connate.

The structure of the tarsal claws will serve to distinguish this group from either of the preceding. The outer stria of the elytra joins the next inner at one-third from the base as in all the Cyphini and the genæ are deeply emarginate.

One genus constitutes this group in our fauna.

APHRASTUS Sch.

Aphrastus Schönh. Curcul. vii, 1, p. 39.

Head broader behind the eyes, vertex convex. Rostrum slightly longer and narrower than the head, moderately robust, subangulate, above flat with a fine groove attaining the vertex, tip and genæ deeply emarginate. Eyes round, moderately convex. Scrobes short, deep, passing directly backward but not reaching the eyes, moderately dilated behind and slightly visible from above. Antennæ moderate; scape slightly arcuate, attaining the thoracic margin; funicle 7-jointed, 1–2 longer, 3–7 short, gradually decreasing and becoming wider; club oval. Thorax cylindrical, slightly narrower in front, apex and base truncate. Scutellum moderate. Elytra ob-

Digitized by Google

long oval, slightly attenuate at apex ; base slightly broader than the thorax, humeri obtuse. Intercoxal process moderately broad, rounded at tip. Second segment longer than the two following united, and separated from the first by a strongly arcuate suture. Articular surfaces of hind tibiæ open, slightly scaly. Claws connate. Anterior and middle tibiæ feebly mucronate, not denticulate within. Surface scaly and hispid.

The second joint of the funicle varies in the two species. It is slightly longer than the first in *tæniatus* and shorter in *unicolor*. Lacordaire is in error in stating that the second joint is twice the length of the first in *tæniatus*.

Our species are two in number.

Second joint of funicle longer than the first ; elytra with four brown stripes.. **tæniatus.**

Second joint of funicle shorter than the first ; elytra uniformly cinereous.. .... **unicolor.**

A. tæniatus Gyll. Schönh. Gen. Curc. ii, p. 460 ; Say Curc. N. A. p. 9, without description.

Head and rostrum shorter than the thorax, densely scaly except at tip ; scales pale brown above, cinereous at the sides and beneath, and with sparsely placed short erect hairs. Thorax cylindrical, slightly narrowed in front, sides feebly arcuate, base squarely, apex obliquely truncate, disc moderately convex, not densely punctured, densely scaly ; scales pale brown ; a pale line on each side of middle, sides and beneath cinereous. Elytra oval, feebly striate, striæ with moderately coarse very regularly placed punctures, intervals feebly convex, surface densely clothed with cinereous scales ; the second and fourth intervals with brownish scales, the inner stripe longer, each interval with a row of very short whitish hairs. Body beneath and legs densely covered with cinereous scales ; tibiæ sparsely hirsute. Length .20–.22 inch ; 5– 5.5 mm.

This insect is very well-known to most collectors. The species has usually been attributed to Say, but as the description of Gyllenhal is really the first, it appears just to so accredit it.

Occurs in the Middle and Southern States.

A. unicolor, n. sp.

Form elongate oval, densely covered with cinereous scales. Head and rostrum as long as the thorax, moderately densely scaly. Thorax regularly cylindrical, sides scarcely arcuate, apex obliquely, base squarely truncate, disc sparsely punctured, surface densely scaly and with whitish erect hairs. Elytra oblong oval, feebly striate, striæ with large rather coarse punctures very regularly placed, intervals feebly convex, densely scaly, each with a single row of short, white, erect hairs. Body beneath, especially the abdomen sparsely scaly. Legs moderately scaly, tibiæ sparsely pilose. Length .18 inch ; 4.5 mm.

This species is rather narrower than *tæniatus ;* thorax more regularly cylindrical, and with the erect hairs more distinctly visible. It differs especially in the structure of the funicle ; the second joint being but little more than half the length of the first.

One specimen. Texas.

Digitized by Google

Tribe III. EXOPHTHALMINI.*

Rostrum longer than the head, usually quadrangular and dilated at tip, the latter emarginate. Genæ not or feebly emarginate. Head not prolonged behind the eyes. Scutellum distinct. Elytra wider at base than thorax (*Omileus* excepted), outer stria entire, not confluent with the next. Articular surfaces of hind tibiæ internal, at least moderately cavernous. Claws free.

This tribe is constructed at the expense of the Cyphides as defined by Lacordaire. It contains those genera in which the rostrum is elongate, the tenth stria entire, and the genæ not or very feebly emarginate. As thus defined, it will probably contain all of the last six genera of the Cyphides. In examining a series of Cuban species presented by Prof. Poey to the American Entomological Society, I find the specimens of *Exophthalmus Sommeri* having the fimbriæ at the sides of the thorax as strongly marked as in any of the genera allied to *Tanymecus*. The elytra are not, each one, prominent at base, and the thorax is feebly bisinuate. It should constitute a new genus of *Tanymecini*. In this tribe will be included (*Geonemus*) *alternans*, in which, however, the elytra are not wider at base than the thorax. The structure of the thoracic parapleuræ separates it from the genera allied to *Epicærus*, etc.

The following groups may be recognized.

Submentum not pedunculate ; mentum broad.
  Humeri prominent ; thorax bisinuate at base............ **Exophthalmi.**
  Humeri very oblique or rounded. Thorax truncate at base.. **Omilei.**
Submentum pedunculated ; mentum narrow.
  Humeri prominent. Thorax truncate at base.......... **Evoti.**

The last group shows strong affinities with the next tribe.

Group I. Exophthalmi.

Rostrum longer than the head, sub-quadrangular, slightly dilated at tip, which is feebly emarginate ; genæ moderately emarginate. Sub-mentum not pedunculate, mentum broader than long, entirely concealing the maxillæ. Antennæ moderate, scape at most merely passing the eye. Scrobes narrow, moderately arcuate, passing beneath the eyes. Thorax distinctly, at times feebly, bisinuate at base. Elytra wider than the thorax at base, or at least with the humeri very distinct, neither oblique nor obliterated. Scutellum distinct. Articular surfaces of hind tibiæ very feebly cavernous, glabrous. Claws free.

One genus represents this group in our fauna.

LACHNOPUS Sch.

Lachnopus Schönh. Curc. vi, 1, p. 380.

Rostrum longer and narrower than the head, slightly broader at tip and feebly emarginate. Vertex convex, separated from the front by a feeble

* This tribe should be known as EVOTINI and would have been corrected had not page 81 been already printed.

Digitized by Google

transverse impression. Eyes large, round, moderately prominent. Scrobes narrow, deep, nearly straight, passing immediately beneath the eyes. Antennæ moderately long, scape gradually clavate, passing the posterior margin of the eyes ; funicle 7-jointed, 1–2 longer, sub-equal, 3–7 shorter, sub-equal; club oval. Thorax oval, narrower in front, truncate at apex, feebly bisinuate at base. Scutellum distinct, moderate. Elytra oblong oval, wider than the thorax, emarginate at base, humeri moderately prominent, obtuse. Intercoxal process of abdomen broad, sub-truncate ; second segment of abdomen longer than the two following together, separated from the first by an arcuate suture. Anterior and middle tibiæ mucronate at tip, and denticulate within, hind tibiæ fimbriate within. Surface partially scaly.

L. floridanus, n. sp.

Form oblong, oval, color black, shining, surface with white scales, very sparsely placed, condensed in small round patches on the elytra. Head and rostrum slightly longer than the thorax, black, shining, moderately densely punctured, and with white scales very sparsely placed. Antennæ brownish, sparsely hairy. Thorax oval, narrowed at apex, slightly broader than long, sides arcuate, base slightly narrower and feebly bisinuate ; disc moderately convex, densely, and rather coarsely punctured, rugulose at the sides, surface black, shining, with whitish scales very sparsely placed. Scutellum smooth, shining. Elytra oblong, oval, base emarginate at middle ; disc moderately convex, and with rows of large, moderately deep punctures, rather closely placed, the third and fourth somewhat irregular at the declivity ; surface black, shining, sparsely punctured and with white scales very sparsely placed, becoming condensed in small round spots, distantly placed on alternate intervals. Body beneath black, shining, sparsely punctured and with very few scales. Legs black, sparsely scaly. Length .26 inch ; 6.5 mm.

This species is of the size of *L. hispidus* Gyll. (Cuba) and of very similar ornamentation. The thorax is, however, narrower at base, eyes more prominent and vertex more convex.

One specimen, Florida.

Group II. Omilei.

Rostrum longer than the head, narrower, quadrangular, and slightly dilated in front. Genæ feebly emarginate. Thorax truncate at apex and base. Elytra not wider than the thorax, feebly emarginate at base, humeri either very oblique or broadly rounded. Articular surfaces of hind tibiæ very feebly cavernous.

The differences between this group and the preceding are feeble, and with other genera would probably be united with it.

Two genera are at present known to me, one only native.

Second segment of abdomen not longer than the two following together, first suture nearly straight. Second joint of funicle short.. **OMILEUS.**

Digitized by Google

Second segment longer than the two following, first suture strongly arcuate. Second joint of funicle longer than the first.. *gen. nov.*

The type of the second genus is *Geonemus alternans* Boh. (Cuba). The articular surfaces of the hind tibiæ are not scaly in this species as stated by Lacordaire, Genera, vi, p. 131. *G. aureosquamosus* Duval, (Cuba) does not belong to the present tribe, but should form a new genus of *Cyphini*, as defined in the present memoir.

OMILEUS n. g.

Rostrum longer than the head and very slightly narrower, cylindrical at base, slightly flattened above, feebly dilated and emarginate at tip; genæ not emarginate. Scrobes deep, well defined, slightly arcuate, passing obliquely beneath and slightly in front of the eyes. Eyes oval, slightly longitudinal. Antennæ moderate; scape attaining the posterior margin of the eyes, feebly thickened; funicle 7-jointed, first joint moderate, second scarcely longer than the third, 3–7 short, sub-equal; club oval. Thorax truncate at apex and base. Scutellum small, oval. Elytra oval, not wider at base than the thorax, humeri broadly rounded. Metasternum moderate. Intercoxal process broad, rounded in front, second segment equal to the two following together, first suture very nearly straight. Anterior and middle tibiæ mucronate. Articular surfaces of hind tibiæ feebly cavernous, glabrous.

O. epicæroides, n. sp.

Form elongate. oval, surface densely covered with cinereous scales, variegated with brown. Head and rostrum slightly longer than the thorax, densely punctured and covered with cinereous scales, at tip nearly naked. Thorax as broad as long, apex slightly narrower than the base, sides strongly arcuate, median line moderately impressed, surface sparsely tuberculate, densely covered with cinereous scales, a broad median and narrow lateral stripe fuscous. Elytra regularly oval, striate, striæ with moderately coarse punctures, intervals feebly convex, and each with two rows of scale-like hairs, surface densely covered with cinereous scales, disc with large fuscous spot nearly divided by a transverse cinereous fascia interrupted at middle. Body beneath densely covered with cinereous scales. Legs densely scaly, femora darker at base. Length .30–.32 inch; 7.5–8 mm.

The facies of this species is almost exactly that of certain elongate forms of *Epicærus imbricatus*, and it would have been placed in the same tribe if the structure of the sternal side pieces were similar.

This species occurs in Texas.

Group III. Evoti.

Rostrum elongate, strongly dilated and auriculate at tip. Scrobes visible from above. Scutellum distinct. Elytra wider at base than the thorax, humeri moderately prominent; marginal stria entire. Articular surfaces of hind tibiæ feebly cavernous. Claws free.

One genus only is known to me which can be placed here.

Digitized by Google

EVOTUS Lec.

Evotus Lec., American Naturalist, 1874, pp. 458–9.

Rostrum horizontal, longer than twice the head, narrower, sub-quadrangular and compressed at base, tip dilated and nearly twice as broad as at middle, auriculate, and broadly emarginate; genæ not emarginate. Sub-mentum distinctly pedunculate. Mentum oval, longer than wide, maxillæ slightly visible at the sides. Scrobes visible from above in front and moderately deep, very nearly straight, very shallow posteriorly, and directed to the lower margin of the eyes. Eyes oval, slightly oblique and sub-acute beneath. Antennæ long, rather slender; scape gradually clavate and attaining the middle of the eye; funicle 7-jointed, slightly longer than the scape, joints 1–2 longer, the second longer than the first, joints 3–7 obconical, the seventh longer than the preceding; club elongate, oval. Thorax transversely oval, apex truncate, base slightly arcuate. Scutellum oval. Elytra oval, broader at base than the thorax, humeri obtuse, moderately prominent. Metasternum moderate, side pieces wide, formed as defined for the division. Intercoxal process broad, oval at tip. Second segment of abdomen slightly longer than the two following together, separated from the first by an arcuate suture. Anterior and middle tibiæ mucronate at tip. Articular surfaces of hind tibiæ feebly cavernous and glabrous. Tarsi rather slender, third joint deeply bilobed, last joint slender and as long as the first two. Claws moderate, free.

This genus has been defined at greater length than has been the custom in this paper, on account of the very remarkable assemblage of characters it presents. Were it not for the very plain scar on the mandibles it might be suspected to have some affinity with the genera allied to *Alophus*, etc.

E. naso Lec. (*Otiorhynchus*) Pacif. R. R. Rep. p. 56; Am. Nat. 1874, p. 459.

Form elongate, oval, color black shining, moderately densely covered with scales, varying in color from ochreous to cinereous. Head and rostrum longer than the thorax, moderately, densely punctured, sparsely scaly, a fine median line, more distinctly impressed on the vertex. Thorax oval, slightly broader than long, narrower in front, apex truncate, base feebly arcuate, sides rather strongly arcuate in front; median line indistinct, disc moderately convex, densely punctured, scales sparse, except on the median line and sides. Scutellum densely scaly and paler. Elytra oval, moderately convex, with rows of moderate punctures, intervals densely punctulate, surface moderately, densely scaly, and variegated with paler spots at the sides. Body beneath and legs densely scaly and hairy, scales pearly. Length .30–.36 inch; 7.5–9 mm.

Occurs rather abundantly in Oregon, and also in Colorado.

Tribe IV. PHYLLOBIINI.

Head prolonged behind the eyes, these round or slightly oval. Mentum small, usually concealing the maxillæ. Rostrum usually stout, cylindrical,

Digitized by Google

truncate or very feebly emarginate at tip. Genæ not emarginate. Scrobes short, sub-terminal. Meso- and metasternal side pieces broad, the former diagonally divided. Articular surfaces of the hind tibiæ terminal, glabrous. Claws connate. Tenth elytral stria free in its entire extent. Scutellum distinct.

The above characters serve to isolate a number of genera evidently closely allied among themselves, and also with well-marked affinity with certain members of the tribe *Cyphini*. The mandibular scar is not prominent in any of our genera, but is round and directly on the face of the mandible itself. The deciduous piece is moderately long, glabrous and regularly falciform. The mentum varies in size in the genera of this group, but not to the extent of causing *Scythropus* and *Phyllobius* to be widely separated.

The following genera compose this tribe in our fauna:

Elytra wider at base than the thorax.
  Mentum entirely concealing the maxillæ......... PHYLLOBIUS.
  Mentum smaller, maxillæ visible at the sides.
    Rostrum slightly narrower than the head; alæ slightly divergent........................... CYPHOMIMUS.
    Rostrum short, stout; alæ not divergent...... SCYTHROPUS.
Elytra elongate, oval, as narrow at base as the thorax.
    Mentum small, maxillæ entirely exposed...... MITOSTYLUS.

In *Mitostylus* the sub-mentum is very slightly pedunculate. *Scythropus* has the gula semicircularly emarginate, and the maxillæ visible at the sides of the mentum, the other three genera have the gular notch nearly square. In the genera 2 and 4 the mentum is very narrow and the other parts of the mouth very distinctly visible.

PHYLLOBIUS Germ.

Phyllobius Germ. Ins. Spec. nov. p. 447.

Rostrum as long as the head and somewhat narrower, feebly dilated and slightly emarginate at tip. Scrobes in the form of fossets, sub-terminal. Eyes oval, slightly oblique, moderately prominent. Antennæ long and slender; scape slender, feebly clavate, attaining the margin of the thorax, funicle 7 jointed, 1–2 longer, the second slightly longer than the first, 3–7 sub-equal, obconical; club elongate oval. Thorax oval broader than long. Scutellum distinct. Elytra broader at base than the thorax, humeri moderately prominent, oblong. Intercoxal process oval. Second segment not as long as the two following united, separated from the first by a suture nearly straight. Femora clavate, the anterior more strongly. Anterior and middle tibiæ mucronate, articular surfaces of hind tibiæ strictly terminal. Claws connate. Body densely scaly.

One species is known to me in our fauna which may be merely accidental in its occurrence as I have seen but one specimen.

Digitized by Google

P. calcaratus Fab. (*Curculio*) Ent. Syst. i, 2, p. 485; Gyll. Sch. Gen. Curc. ii, p. 435.

Oblong, black, moderately, densely covered with bluish-green piliform scales, legs reddish. Head and rostrum longer than the thorax, densely punctured, sparsely scaly. Thorax broader than long, slightly constricted and narrower at base than apex, sides rather strongly arcuate, disc convex, moderately densely punctured, not densely scaly. Elytra oblong, parallel, acuminate posteriorly, nearly three times as long as wide, striate, striæ with moderate punctures, intervals feebly convex, densely punctured and moderately, densely scaly. Body beneath very sparsely covered with piliform scales. Legs rufous, sparsely hairy, femora strongly dentate. Antennæ rufous. Length .30 inch; 7.5 mm.

One specimen from Canada.

The Catalogus of Gemminger and Harold gives *glaucus* Scop. as an older name. As the species is introduced and hardly concerns our fauna, I adopt the name used by English entomologists, leaving bibliography to those more intimately concerned.

CYPHOMIMUS n. g.

Rostrum a little shorter and narrower than the head, sub-cylindrical, alæ slightly divergent, genæ not emarginate, tip feebly notched. Head moderately prolonged behind the eyes. Scrobes cavernous in front, suddenly flexed, passing beneath at some distance from the eyes. Eyes round, moderately prominent. Antennæ rather slender. Scape slender, gradually thicker to tip and nearly attaining the margin of the thorax; funicle 7-jointed, first joint nearly as long as the two following, 2–7 obconical, gradually decreasing in length; club elongate, oval. Thorax cylindrical, slightly narrower in front. Scutellum small, triangular. Elytra wider at base than the thorax, humeri moderately prominent. Metasternum moderate. Intercoxal process oval at tip. Second segment of abdomen longer than the two following, first suture arcuate at middle. Tibiæ not mucronate, articular surface of hind tibiæ terminal, glabrous. Claws connate at base. Marginal elytral stria free.

In form and general appearance the only species composing the genus resembles *Brachystylus acutus* but with a longer head and rostrum.

C. dorsalis, n. sp.

Form oblong, oval, narrowed in front, surface densely scaly. Head and rostrum as long as the thorax, surface densely covered with whitish scales, a dark stripe on the vertex and behind each eye, and with erect, short hairs. Thorax cylindrical, slightly wider than long, narrower and feebly constricted in front, apex obliquely, base squarely truncate, sides feebly arcuate, apical margin above slightly thickened, surface sparsely punctured and with short, erect hairs, densely covered with cinereous scales, and with three longitudinal stripes darker. Elytra nearly twice as wide as the thorax, humeri prominent, sides slightly divergent, surface striate, striæ punctured, intervals flat, with a single row of short black hairs, densely

Digitized by Google

covered with cinereous scales, a large discal space fuscous, very broad at the declivity, extending anteriorly along the intervals 1–2–3 and at base 4; third interval at base with a cinereous line; a small fuscous spot at the tip of the fifth interval. Body beneath piceous, shining, sparsely scaly. Legs rufous, femora at middle piceous, sparsely scaly and pilose. Length .20 inch; 5 mm.

One specimen, Missouri.

Can this possibly be *Polydrosus americanus* Gyll. ? (Sch. Gen. Curc. ii, p. 136). I cannot otherwise identify the species.

SCYTHROPUS Sch.

Scythropus Schönh. Curc. Disp. Meth. p. 140.

Rostrum, short, stout, slightly narrowed in front, angles rounded, de clivous and truncate at tip, with arcuate carina and smooth space. Scrobes short, badly limited and slightly arcuate. Eyes distant from the thorax, round, slightly prominent. Antennæ long, scape long, slender, gradually clavate, slightly arcuate and passing the eyes behind; funicle 7-jointed, 1–2 longer, the first slightly longer than the second, 3–7 shorter, gradually decreasing; club elongate, oval. Thorax short, cylindrical, slightly narrower in front. Scutellum small, nearly oval. Elytra wider at base than the thorax, feebly emarginate, humeri obtusely prominent. Metasternum moderately long. Intercoxal process oval at tip. Second abdominal segment longer than the two following together, first suture arcuate at middle. Articular surfaces of hind tibiæ terminal. Tarsal claws small, connate at base. Body densely scaly.

In addition to the above characters it will be seen that the gular notch is semicircular, the mentum small and rather narrow. The mandibles are short, robust, glabrous, the scar oval, terminal and not prominent. The deciduous pieces are long, moderately stout and falciform.

Two species occur in our fauna. In one, *elegans*, the anterior and middle tibiæ are sinuate within, especially in the ♂, the other, *californicus*, the tibiæ are scarcely perceptibly sinuate. The vestiture also varies and may be thus expressed:

Body densely covered with scales of variable color from brilliant green to cinereous, suture always, sides usually of paler color.............................. **elegans.**

Body less densely covered with piliform scales, brownish or ferruginous, region of the suture marmorate with white .... **californicus.**

S. elegans Couper. (*Polydrosus*) Canadian Naturalist, 1865, p. 63.

Form oblong, densely scaly. Head and rostrum as long as the thorax, surface densely scaly except at tip. Thorax wider than long, apex and base truncate, a slight constriction at the sides behind the apical margin, sides moderately arcuate, disc moderately convex, surface densely scaly. Elytra oblong, gradually broader behind the humeri, narrowed at apical

Digitized by Google

third, striate, striæ finely and closely punctured, intervals flat, densely scaly and with minute sub-erect hairs. Body beneath densely scaly and in color similar to the upper surface. Legs piceous or piceo-rufous, femora densely scaly, tibiæ paler and more distinctly pubescent. Length .20–.28 inch ; 5–7 mm.

The color of the scales is very variable and may be rather brilliant green, slightly cupreous, plumbeous or cinereous. Usually the sides of the elytra are paler than the rest of the surface, the suture always so.

Occurs from Canada to California.

S. californicus, n. sp.

Form of *elegans* but slightly narrower. Surface less densely covered with brownish or ferruginous piliform scales, the region of the suture irregularly marmorate with white. Thorax scaly, broader than long. Legs pale rufous, sparsely pubescent. Tibiæ very feebly arcuate. Length .24 inch ; 6 mm.

These few words give the differences observable between the two species. The head is also narrower, and the rostrum less robust. *S. californicus* resembles the *mustela* of Europe.

Two specimens, Eldorado Co., California.

MITOSTYLUS n. g.

Rostrum cylindrical, shorter than the head, slightly narrower, tip very feebly emarginate, and with a smooth triangular space. Scrobes short, badly defined, suddenly flexed. Eyes longitudinally oval, slightly truncate in front. Antennæ slender, three-fourths the length of the entire body; scape long, slender, slightly clavate and attaining the margin of the thorax; funicle 7-jointed, 1–2 longer, the first longer than the second ; 3–7 obconical, gradually shorter ; club elongate, oval, pointed at tip. Thorax cylindrical, sides feebly arcuate. Scutellum small, triangular. Elytra not wider at base than the thorax, oblong oval. Metasternum rather short. Intercoxal process broadly oval, second segment longer than the two following, first suture arcuate at middle. Tibiæ straight, tarsi slender, claws connate. Tenth elytral stria free in its entire extent. Body densely scaly.

The gular notch is rhomboidal, the mentum narrow, an extremely feeble peduncle, maxillæ distinctly visible, and the labial palpi rather prominent. This insect resembles the figures of *Eusomus ovulum.*

M. tenuis, n. sp.

Form rather slender, surface densely covered with bluish white scales. Head and rostrum longer than the thorax, sparsely punctured, moderately densely scaly. Thorax cylindrical, as wide as long, sides feebly arcuate, apex slightly obliquely, base squarely truncate and slightly narrower than the apex, disc moderately convex and scaly, sparsely punctured. Elytra oblong oval, striate, striæ moderately closely punctured, intervals flat, densely scaly and with minute, erect, whitish hairs. Body beneath densely scaly. Legs rufous, femora darker and sparsely scaly, tibiæ pubescent. Length .12–.14 inch ; 3–3.5 mm.

Digitized by Google

This insect has been mentioned by Dr. Leconte (Amer. Nat. 1874, p. 457) as being probably a *Macrostylus*.

Occurs in Texas.

Tribe V. PROMECOPINI.

Rostrum short, stout, dilated, (*Coleocerus*) or not (*Eudiagogus*) in front, tip emarginate. Antennæ moderate, scape passing the eyes or not, funicle 7-jointed; club oval. Scrobes deep, arcuate, confluent or not beneath. Thorax with large lateral lobes and deeply emarginate beneath. Scutellum distinct. Abdomen normal. Tibiæ feebly mucronate. Tarsal claws free.

This tribe, corresponding with that of Lacordaire, may be considered the most sharply defined and natural of the division. Its small and retracted mentum, large thoracic lobes and the deep emargination of the front of the thorax beneath, at once distinguish it. As in the preceding tribe the genæ are entire and the mandibles covered at base.

The following are the genera in our fauna:

Rostrum strongly dilated at tip, scrobes meeting beneath the eyes ; mesosternum protuberant... **COLEOCERUS.**

Rostrum very feebly dilated, cylindrical flattened, scrobes not meeting beneath the eyes but turning forward. Mesosternum not protuberant.

Elytra broadly oval, scutellum small. Metasternum short... **ARACANTHUS.**

Elytra oblong, broader at base than the thorax, scutellum transverse. Metasternum moderately long... **EUDIAGOGUS.**

In the last two genera the articular cavities of the hind tibiæ are shallow, the outer free edge is, however, double in *Eudiagogus*. In *Coleocerus* the hind tibiæ is truncate at tip, forming an oval, scaly space, the outer edge of which is formed by a moderately sharp ridge not margined with spinules. The tibiæ are feebly mucronate in all of the genera, although the contrary is stated by Lacordaire.

COLEOCERUS Sch.

Coleocerus Schönh. Gen. Curc. v, p. 927.

Bathyris Lec. Amer. Nat. 1874, p. 461.

Rostrum not longer nor narrower than the head, very short and stout, alæ prominent laterally and beneath, tip emarginate, in front of each eye a triangular impression, above a longitudinal groove. Scrobes sharply defined, arcuate and confluent beneath. Eyes oval, pointed beneath, not prominent. Antennæ moderate; scape gradually clavate, attaining the front of the eyes; funicle 7-jointed, 1–2 longer, the first longer than the second, 3–7 short, gradually decreasing; club oval. Thorax variable, trapezoidal (*dispar*) or transverse (*marmoratus*), ocular lobe broad and prominent. Scutellum transverse, enclosed by the elytra. Elytra oblong oval, parallel,

Digitized by Google

slightly wider than the thorax (*marmoratus*) or not. Mesosternum protuberant in the form of an obtuse spine. Metasternum moderate, side pieces wide. Intercoxal process broad, oval at tip, second segment longer than the two following united, first suture strongly arcuate. Anterior and middle tibiæ mucronate, articular surface of hind tibiæ internal, cavernous, the tip truncate, and with oval scaly space. Claws free. Body oval, densely scaly.

The scar left after the disappearance of the deciduous piece is small and difficult at first to discover, and the genus was placed in the following subfamily. (Amer. Nat. 1874, p. 461). Two other genera are very closely allied to this, and should probably not be separated, *Pororhynchus* and *Periorges*. The former has the thorax margined near the base as in *Coleocerus*, but the mesosternum is not protuberant; the latter has the protuberant mesosternum, but not the thoracic margin. One of our species (*marmoratus*) might be referred to *Periorges*, but the mesosternum is protuberant exactly as in *Coleocerus*, while in that genus the protuberance is slight and somewhat laminiform.

Two species occur in our fauna.

Thorax margined at the sides, at base........................ **dispar.**
Thorax not margined.. **marmoratus.**

C. dispar Lec. (*Bathyris*) Amer. Nat. 1874, p. 462.

Form oblong oval, densely scaly. Head and rostrum as long as the thorax. Rostrum deeply sulcate, moderately densely punctured, and densely covered with rounded scales, of dark cinereous color, a paler line on the vertex. Thorax rhomboidal, gradually narrower from base to apex, sides dilated near the hind angles, and with a short sub-acute ridge, disc moderately convex, densely covered with dark cinereous scales, median line and sides paler, a small spot on each side of middle darker. Scutellum white. Elytra oblong, not wider than the expanded thorax, striate, striæ with moderately large punctures, intervals flat, each with a row of short, erect hairs; surface densely covered with brownish scales; tip, and a short oblique band in front of middle cinereous. Body beneath and legs densely covered with nearly white scales, darker on the outer side of the legs. Length .18 inch; 4.5 mm.

One specimen. Arizona, Dr. Webb. From memory alone, I am inclined to think this species identical with *C. variegatus* which I saw in the cabinet of M. Aug. Sallé, of Paris.

C. marmoratus, n. sp.

Form of *dispar*, densely scaly. Thorax broader than long, sides moderately arcuate, widest at middle, disc moderately convex, covered densely with whitish scales, with black and fuscous sparsely intermixed, and a transverse basal band black. Scutellum white. Elytra oblong oval, indistinctly striate, and with moderately large punctures distantly placed, intervals flat without erect hairs, surface densely scaly; scales cinereous and brown intermixed, and with three very irregular black fasciæ; the first oblique, the second median, transverse, the third sub-apical. Body beneath

Digitized by Google

and legs densely covered with cinereous and brown scales irregularly intermixed. Length .16 inch; 4 mm.

This species is relatively more robust than the preceding. It appears to constitute a form intermediate between the genus *Periorges* and *Coleocerus*. It is certainly not the female of *dispar* as suspected by Dr. LeConte.

Occurs in Texas.

ARACANTHUS Sch.

Aracanthus Schönh. Gen. Curc. v, 1, p. 821.

Rostrum scarcely longer than the head, stout, parallel, finely canaliculate above, tip feebly emarginate. Scrobes linear moderately arcuate, passing immediately in front of the eyes beneath the head, and turning slightly forward. Eyes transversely oval, pointed beneath. Submentum with a short broad peduncle, not emarginate. Antennæ moderate, scape gradually clavate, attaining the middle of the eye; funicle 7-jointed, 1–2 longer, the first longer than the second, 3–7 gradually shorter, slightly flattened; club oval. Thorax slightly wider than long, ocular lobes prominent. Scutellum very small, triangular. Elytra oval, very little broader than the thorax at base, humeri rectangular. Mesosternum oblique, metasternum short. Intercoxal process oval at tip. Abdomen normal. Anterior and middle tibiæ feebly mucronate, articular surfaces of hind tibiæ terminal, not cavernous. Claws free.

This genus is closely allied to *Eudiagogus*, and differs in having the thorax nearly as wide at base as the elytra; the scutellum very small, and the peduncle of the submentum not emarginate. The genus was named, but not characterized by Say.

A. pallidus Say, Curc. p. 9; Compl. works, 1, p. 268; Schönh. loc. cit.

Form oval, surface densely scaly. Head and rostrum not longer than the thorax, canaliculate, moderately, densely, punctured, and moderately covered with scales of a cupreous lustre. Thorax slightly wider than long, base arcuate, sides in front arcuate, posteriorly sub-sinuate, disc convex, with coarse, rather closely placed punctures, surface densely scaly, scales fuscous, sides and median line paler. Elytra oval, scarcely striate and with rows of moderately large punctures not closely placed, surface densely covered with cinereous scales, finely variegated with fuscous, and with short, erect, whitish hairs. Body beneath and legs very sparsely scaly. Length .12 inch; 3 mm.

Many of the scales covering the surface have a slight cupreous lustre, especially those near the sides.

Occurs in Texas and Missouri.

EUDIAGOGUS Sch.

Eudiagogus Schönh. Gen. Curc. vi, 1, p. 307.

Rostrum as long as the head, stout, slightly narrower in front, alæ very feebly prominent, tip slightly notched, genæ entire. Gula quadrangularly emarginate, submentum pedunculate, and deeply emarginate, mentum small, retracted. Eyes oval, pointed beneath. Scrobes narrow, well-de-

Digitized by Google

fined, passing immediately beneath, and slightly beyond the lower border of the eye, not continued beneath the beak. Antennæ moderate; scape gradually clavate, slightly arcuate, passing slightly the anterior border of the eye; funicle 7 jointed, 1–2 feebly elongated, the first longer than the second, 3–7 gradually smaller; club oval. Thorax broader than long, base slightly narrower, ocular lobes very prominent. Scutellum oval or transverse. Elytra oblong, wider at base than the thorax, humeri oblique, sides parallel. Mesosternum not protuberant. Metasternum short. Intercoxal process broad, oval at tip. Second abdominal segment longer than the two following, first suture strongly arcuate. Anterior and middle tibiæ mucronate at tip, articular surface of hind tibiæ internal, not cavernous. Claws free. Body densely scaly.

This genus may be at once distinguished from all the others of the tribe by the acute emargination of the submentum.

Two species occur in our fauna, which are distinguished as follows:

Scutellum transverse, twice as wide as long. Thorax with four discal black spaces, the two basal smaller. Black stripes of elytra regular............ **pulcher.**

Scutellum smaller, oval. Thorax with two broad, discal, black stripes narrowly separated. Black stripes of elytra with irregular margins............ **Rosenschœldi.**

E. pulcher Fahrs. Schönh. Gen. Curc. vi, 1, p. 310.

Form oblong, densely scaly. Head and rostrum shorter than the thorax, densely covered with cupreous scales, a round spot black. Rostrum with impressed median line, tip with feeble triangular impression. Thorax broader than long, sides strongly arcuate in front, and gradually narrowing to base, the latter slightly arcuate, disc moderately punctured, surface densely covered with cupreous scales, and with four black spots; the posterior smaller, sides of thorax cupreous, beneath the margin a black spot. Scutellum transverse. Elytra oblong, moderately convex, with rows of moderate punctures not closely placed; surface densely scaly, sutural interval cupreous; a broad, black stripe slightly narrowed at its middle, and not attaining the tip, at the side two oblong black spots, one humeral, the other sub-apical, sometimes united in an entire stripe, limb and lateral vitta cupreous. Body beneath less densely scaly, scales pale cupreous, a black spot at the side of the first two ventral segments. Legs less densely scaly, femora nearly nude at apex and base. Tibiæ with short, spinulose hairs within. Length .16–.32 inch; 4–8 mm.

Two varieties occur. One has the lateral black stripe entire, in the other it is broadly divided.

Occurs usually in the first variety in Florida, and in the latter in Texas.

E. Rosenschœldi Fahrs. Schönh. Gen. Curc. vi, 1, p. 309.

Form oblong oval, densely scaly. Thorax as long as wide, sides in front rather suddenly convergent, posteriorly nearly parallel, disc sparsely punctured, densely covered with cupereous scales; a broad, entire black stripe

Digitized by Google

on each side of the middle. Elytra less elongate than in *pulcher*, densely scaly, scales cupreous; a broad, black stripe on each side of the suture much confused at tip, lateral black stripe much more confused or even absent. Scutellum oval. Length .28 inch; 7 mm.

The above notes give the differences between this species and the preceding. It is always less elongate and more robust.

Occurs in Louisiana.

Family VI. CURCULIONIDÆ.

Mentum varying in size, never concealing the base of the maxillæ, larger in the first sub-families and tribes, smaller and oval in those last placed in this memoir, ligula and palpi also varying in size.

Maxillæ exposed, palpi short, 4-jointed, rigid.

Mandibles varying according to sub-family and tribe, as mentioned below, but never with an apical scar.

Antennæ inserted at the side of the beak, varying in position, usually geniculate (only feebly so in *Ithycerus*, *Cleonini*, *Piazorhinus*, and *Tachygonus*), with the scape long, (short in *Ithycerus*, *Piazorhinus*, and *Tachygonus*); funiculus with from 5–7 joints; club composed of three joints and a terminal appendix, annulated, rarely articulated, and then divided into three joints; surface usually entirely sensitive, rarely (*Pissodes*, *Lissorhoptus*, *Eurhoptus*, *Baris*,) with the basal joint shining.

Head globose, eyes usually transverse, sometimes round; beak varying in form and length, labrum wanting.

Prothorax varying in form, without lateral sutures separating the prosternum; coxal cavities confluent or separate, enclosed behind.

Mesosternum variable in width, side pieces differently divided according to tribe, never attaining the coxal cavity. Metasternum variable in length, side pieces sometimes broad, sometimes narrow, indistinct only in *Trachodes*.

Elytra without epipleuræ, but with an acute fold on the inner surface, limiting a deep groove in which the superior edge of the abdomen fits; pygidium sometimes covered, sometimes exposed.

Abdomen with five ventral segments, first and second closely connate; pygidium of male divided so as to form an anal segment.

Front coxæ rounded, sometimes contiguous, sometimes distant; middle coxæ rounded, more or less separated; hind coxæ oval, not prominent, more or less distant, sometimes attaining the elytral margin, but usually entirely enclosed

Legs variable; tibiæ usually mucronate, or hooked at tip; sometimes (especially the hind pair) truncate. Tarsi usually dilated, with the third joint bilobed and spongy beneath, rarely narrow. Claws varying according to tribe, either simple or toothed, diverging and moveable, or fixed and approximate; sometimes connate, and rarely single (*Brachybamus*, *Mononychus*, *Barilepton*), entirely wanting in some foreign genera.

Digitized by Google

This family is by far the largest in the *Rhynchophora*, and therefore exhibits a greater range of variation in some of the important organs than can be seen in the other families. Certain of the most remarkable divergences from the average type may, however, be separated as sub-families, exhibiting relationships with other families, without losing the essential characters of this family; that is to say, the mandibles without scar, the tarsi with the third joint more or less dilated, not spinous beneath, the antennæ with annulated or articulated club.

Of such sub-families I recognize five in our fauna; all of very limited extent, except the *Curculionidæ* (*genuini*).

They may be separated as follows:

A. Condyles of mandibles on outer side. motion lateral.

Mandibles stout, feebly emarginate at tip, with the inner edge sharp; gular peduncle broad; beak short, broad......... .... SITONIDÆ.

Mandibles without sharp inner edge; apparently emarginate at tip, with an additional cusp:

Antennæ geniculate; gular margin prominent, peduncle and mentum retracted. ALOPHIDÆ.

Antennæ straight, gular margin not prominent; claws toothed (p. 120)........... ITHYCERIDÆ.

Mandibles varying in form, usually 3-toothed, sometimes oblique without teeth*, gular margin not prominent, peduncle usually long (p. 121).................................... CURCULIONIDÆ.

B. Condyles of mandibles on upper side, motion vertical (p. 321)...................................... BALANINIDÆ.

Sub-family I. SITONIDÆ.

The species of this sub-family have been heretofore classed with the Otiorhynchide group *Naupacti*. They differ, however, essentially by family characters; the mandibles are short, very stout, with the outer side convex, roughly punctured, and quite destitute of the apical scar which indicates the deciduous cusp; they are broadly emarginate at tip, and the inner edge is acute. These insects are easily known from other Curculionidæ by the mentum larger, more quadrate, slightly concave, and supported on a broad, but not long, gular peduncle. The maxillæ are exposed as in the lower Otiorhynchidæ, and as in all Curculionidæ, and it therefore seems singular that Lacordaire should have classed them with his Adelognathes Cyclophthalmes, without noting the exception in this respect which they make in common with *Cratopus* and *Elytrodon*.† The condyle of

* In *Desmoris* they are also toothed on the outer edge as in Rhynchitidæ.

† Lacordaire, Gen. Col. vi, 19, note.

Digitized by Google

the base of the mandible is visible on the outer side, the beak is short, broad, flat, and emarginate at tip. The antennal grooves extend forwards quite to the base of the mandibles; they are short and curve abruptly downwards behind the insertion of the antennæ, which are geniculate, with elongate annulated club covered with sensitive surface. The eyes are small, rounded, convex, and rather finely granulated. The front coxæ are contiguous and prominent, the hind coxæ widely separated and extend to the side margin ; the tibiæ truncate at tip, without terminal hook. Tarsi dilated, spongy beneath ; claws slender, simple, divergent. The ventral segments are not very unequal, and the sutures are nearly straight. The side pieces of the mesothorax are diagonally divided, and the epimera do not largely attain the prothorax ; those of the metathorax are narrow, and suddenly dilated in front.

SITONES Sch.

A few species of this well-known genus occur in our fauna, and as will be observed below, several of them are also found in Europe. They may be tabulated as follows :

Setæ of elytral interspaces very obvious..	2.
Setæ of elytral interspaces not, or feebly visible..............................	4.
2. Eyes not prominent..	3.
Eyes convex prominent, elytra tesselated...............	1. **lineellus.**
3. Elytra tesselated...	2. **californicus.**
Elytra uniform dirty brown....................................	3. **sordidus.**
Elytra striped with pale	4. **vittatus.**
4. Frontal groove deep...	5.
Frontal groove fine, color uniform brown..............	5. **flavescens.**
5. Elytra gray with broad white stripes......................	6. **tibialis.**
Elytra gray without stripes, form narrower............	7. **crinitus.**

1. **S. lineellus** Gyll., Sch. Curc. ii, 111; Allard, Ann. Ent. Soc. Fr., 1864, 354 ; *Curculio lin.*, Bons., Curc. Suec. ii, 30, f. 18, et auctorum Europ. ; *S. indifferens* Say, Curc. 10 ; ed. Lec. i, 269 ; *S. scissifrons* Say, ibid.

Kansas two specimens. I have not copied the European synonymy, which may be found in Schönherr. It varies greatly in size, the larger specimen being 7.5 mm. long.

2. **S. californicus** Fahr., Sch. Curc. vi, 267 ; Mannh., Bull. Mosc. 1843, ii, 289 ; *S. californius* (err. typ.) Allard, Ann, Ent. Soc. Fr. 1864, 370.

California and Oregon, abundant. This species also varies in size from 6.3 to 4.2 mm.

3. **S. sordidus** Lec., Pac. R. R. Expl. and Surveys, Entom. 54.

California, San Francisco and St. Diego. Closely allied to the preceding and perhaps only a race of the same species. The form is a little less elongate, the prothorax more rounded, and the scales of a uniform dirty brown.

4. **S. vittatus** Lec., Pac. R. R. Expl. and Surveys, Entom. 54.

San Francisco, California. Also closely allied to *S. californicus*, but the

Digitized by Google

elytra are not tesselate, but striped, and the sides of the prothorax are more rounded, as in *S. sordidus*.

5. **S. flavescens** Allard, Ann. Ent. Soc. Fr., 1864, 346; *Curc. flav.* Marsham, Ent. Brit., 311; *S. octopunctatus* Fahr., Sch. Curc. vi, 269. cum mult. synon. Europ.; *S. lepidus* Gyll., Sch. Curc. ii, 104.

Atlantic States, abundant, especially near the sea shore. Quite distinct from all the preceding by the absence of erect setæ, and by the scales being narrow, hair-like and extremely small. It is abundant and widely diffused in Europe, but the American race differs from the European by the color of the scales being more rusty and less gray.

6. **S. tibialis** Germ., Ins. Nov. 416; Gyll., Sch. Curc. ii, 114; Allard, Ann. Ent. Soc. Fr., 1864, 350; *Curc. tib.* Herbst, Col. vi, 217, pl. 75, f. 5; cum synon. Europ.; *Grypidius vittatus* Couper, Can. Naturalist, 1865, 63.

Widely diffused in Europe, where it varies greatly in size. I have received several specimens from Canada, collected by Mr. W. Couper, as types of the synonym above mentioned. It has perhaps been introduced in earth around roots of shrubs or trees; though I have one specimen from Kansas, one from Hudson Bay territory, and several from Dacota.

7. **S. crinitus** Gyll., Sch. Curc. ii, 124; Allard, Ann. Ent. Fr., 1864, 356; *Curculio cr.* Oliv., Ent. 83, 382; pl. 35, f. 550, cum mult. syn. Europe. *S. seniculus* Mannh., Bull. Mosc. 1843, ii, 290.

Europe, and Northern Asia; Oregon, and California. I have three specimens from Oregon, referable to this species, which is easily known by the very small size, narrow form, and absence of distinct erect setæ; the covering is squamose, grayish-white, obscurely striped on the prothorax, feebly banded on the elytra. Length 3.3 mm; 13 inch.

Sub-Family II. ALOPHIDÆ.

The small group of Curculionidæ, represented in Europe by *Alophus*, and in our fauna by several other genera, is sufficiently distinct in its oral structure to warrant its reception as a sub-family. The convex oval elytra, without humeral angles, and with the posterior part strongly deflexed, added to the more or less rounded prothorax, give an appearance not unlike certain Otiorhynchidæ; and the prolongation of the antennal grooves to the tip of the rostrum, which is rather stout, increases the resemblance.

There are, however, radical differences in the mandibles; which are nearly flat externally and punctured; pincer-shaped, with a sharp edge at the apex, which is more or less emarginate, and without apical scar or deciduous piece. The mentum is tolerably large, trapezoidal and flat, retracted with the gular peduncle, which is broad; the posterior edge of the latter is prominent, so that the mouth appears hollow; the maxillæ are exposed, as are also the ligula and palpi.

The beak is as long as the prothorax, rather stout, usually a little wider at tip, with distinct apical wings; the tip is feebly emarginate, and marked also in the first two genera with a deep angulated impression, from which

Digitized by Google

runs backward (except in *Lophalophus*) a medial groove. The eyes are transverse, narrowed below, and finely granulated. The antennæ are geniculated; the scape long, the funicle seven-jointed (the first and second joints longer), the club annulated, oval, pointed; the antennal grooves usually long, well-defined, narrow, and reaching nearly to the lower angle of the eye, except in *Lophalophus*, where they are wider and shorter. The prothorax is distinctly lobed behind the eyes; the front coxæ are contiguous and prominent. The metasternum is nearly as long as the first and second ventral segments, and the side pieces are narrow; first, second and fifth ventral segments long; third and fourth united equal to either of the others. Legs moderate in length, slender; tibiæ truncate at tip, hind pair not mucronate at the inner angle; tarsi dilated, claws entire, separate.

Our genera are as follows:

A. Beak deeply channeled; tarsi brush-like beneath.
Elytra oval, nearly smooth with faint striæ.... TRIGLYPHUS.
Elytra oblong oval, with distinct humeri, scabrous punctured, with distinct rows of punctures.. PLINTHODES.
B. Beak more finely channeled:
Tarsi setose beneath; elytra with strong rows of punctures, pubescent mixed with scales....................... .... ACMÆGENIUS.
Tarsi brush-like beneath, elytra with obsolete striæ, pubescence above not mixed with scales .... TRICHALOPHUS.
C. Beak finely carinate; elytra with rows of punctures, squamose, with small intermixed bristles.................................. LOPHALOPHUS.
D. Beak not carinate; body covered with scales with rows of bristles on the elytra; second joint of funiculus much shorter than first, equal to the third................ LEPIDOPHORUS.

TRIGLYPHUS n. g.

Beak as long as the prothorax, stout, subcylindrical; tumid under the base of the antennæ, so as to be broadly and feebly winged; medial groove very deep, separating near the tip into two diverging lines, tip emarginate; sides with a deep groove extending from the upper part of the eye almost to the antennal groove; the latter is deep, extending to the tip, ending at the lower angle of the eye, where it is joined by an anteocular transverse impression. Gular margin prominent, as in the other genera of this sub-family; parallel grooves run backwards from the buccal fissures to the base of the beak, where between them is seen a short groove, wider behind. Antennæ rather slender, funicle seven-jointed, joints one to three

Digitized by Google

gradually shorter, four to six equal, seventh wider but only a little longer, club oval, pointed, not as long as the three preceding united.

Prothorax rather small, sides broadly and feebly lobed behind the eyes, narrowed before and behind, not wider than long, truncate at tip and base; coarsely granulate and punctured; transversely impressed beneath, near the tip.

Elytra oval convex, more than twice as wide as the prothorax in ♀, elongate oval and one-half wider than the prothorax in ♂, with nine rows of shallow punctures, interspaces rugose and sparsely punctured, nearly glabrous, with a few scattered scales in the larger punctures, humeri rounded, scutellum very small, pubescent.

Legs moderately long and slender, thighs somewhat clubbed, and sinuate towards the tip; front tibiæ subsinuate on the inner side, curved inwards and mucronate at tip; the other tibiæ are expanded somewhat at tip, truncate and feebly mucronate. Tarsi shorter than the tibiæ, claws separate.

T. **ater**, n. sp.

Black, nearly opaque (♂), or dull (♀), beak and head strongly not densely punctured; prothorax punctured towards the middle, coarsely granose at the sides, with a narrow sometimes indistinct dorsal line; elytra rugose and punctulate, with rows of larger punctures in which are scattered pale scales; beneath with small scattered patches of ochreous scales. Length 12—14 mm.; .45—.6 inch.

California: Dr. Horn and Mr. Crotch. The patches of scales beneath are on the prosternum in front of the coxæ; the outer angle of the metasternum, and at the sides of the ventral sutures. This singular insect has some resemblance in appearance to *Molytes*, but is more slender, and the characters totally unlike. The elytra are more strongly declivous behind than in the other genera, being in fact perpendicular towards the tip.

PLINTHODES n. g.

Beak as in *Triglyphus*, except that the apical wings are a little wider, and the lateral grooves not so deep, there is also a vague groove between the medial and lateral grooves. Antennæ with the second joint of the funicle longer than the first, and together equal to the four following united: three to seven equal, the seventh a little wider, club oval pointed, as long as the three preceding. Prothorax not narrowed behind, rounded and narrowed on the sides in front, postocular lobes broad, feeble; transversely impressed beneath, and at the sides near the tip.

Elytra oblong-oval, wider in ♀ than in ♂, nearly truncate at base, slightly impressed on the sides behind the humeri, which are rounded but distinct, tip gradually declivous (but not perpendicular); very densely scabrous, with rows of large deep punctures; pubescence fine, sparse, with small scattered narrow pale scales, and two small spots on each elytron; scutellum clothed with ochreous scale-like hairs. Legs as in *Triglyphus*.

The beak is very densely punctured; the prothorax the same, mixed with granules at the sides; the under surface is pubescent, densely but not

Digitized by Google

scabrous punctured. The general aspect is that of certain *Hylobius*. The last ventral segment in both sexes is broadly channeled, and with a shallow impression each side; faint traces of similar impressions may be seen in Triglyphus.

The only species known to me is

P. tæniatus Lec., Pac. Rw. Expl. and Surv. Insects, 55, (*Hylobius?*)

Brownish black, thinly clothed with fine brown pubescence, opaque, densely scabrous punctured; thorax granose at the sides, feebly channeled, elytra with rows of deep oblong punctures, scutellum, two small spots on the fifth interspace, and a small sub-humeral spot pale yellow. Length 13 mm.; .55 inch.

Oregon and Vancouver Island.

ACMÆGENIUS n. g.

The beak is rather shorter and stouter than in the preceding genera, flat above, with a medial channel; the lateral grooves are represented by a short impression, and immediately below is a shorter one, the two together occupying the triangular space in front of the eyes; the antennal grooves are very strong and deep, the apical wings moderate; the tip is emarginate but the angulated line is replaced by a broad curved impression. The antennæ are stouter, first and second joints of the funiculus equal, each nearly twice as long as the following, which are equal and about as long as wide, with long bristles, seventh wider, club oval pointed.

Prothorax wider than long, narrowed in front but not behind, very densely punctured not granose, impressed beneath as usual; postocular lobes feeble. Elytra not much wider than the prothorax, elongate oval, strongly declivous behind, humeri not distinct; densely punctured, thinly clothed with mixed scales and hairs, with rows of deep oblong punctures.

Legs as in the preceding genera, except that all the tibiæ are more expanded at the tip, and the tarsi, instead of being brush-like beneath, are concave and thinly clothed with long bristles.

A. hylobinus, n. sp.

Dull black, with a brown tinge, produced by thinly dispersed hairs and small scales; head and prothorax very densely coarsely punctured, elytra more finely punctured, with rows of large oblong punctures: beneath, and legs densely punctured. Length 11 mm.; .43 inch.

Oregon, two specimens; the last ventral is obsoletely impressed along the median line.

TRICHALOPHUS n. g.

This genus contains several species resembling the European *Alophus*, but of larger size, with the rows of elytral punctures almost or quite obliterated; the upper surface is clothed with hairs, not at all squamose, and becoming so only on the sides of the sternal pieces; there is one lateral groove on the beak, and the medial groove is stronger than in *Alophus*;

Digitized by Google

the second joint of the funiculus is a little longer than the first, as in *Alophus*, and in all other respects it agrees with that genus.* The head and prothorax are densely punctured, the latter usually channeled and carinate, the anterior transverse impression strong, sometimes extending on the dorsal surface; the elytra are densely but more finely punctured; the tarsi are broad and scopiferous as usual.

The species may be thus distinguished:

Pronotum strongly transversely impressed near the tip; dorsal channel strong in front, carinate behind:
- Pronotum less coarsely punctured........................ 1. **didymus.**
- Pronotum more coarsely punctured........................ 2. **constrictus.**

Pronotum scarcely impressed near the tip:
- Lateral groove of rostrum distinct; pronotum carinate about the middle:
  - Elytral striæ nearly obliterated........................ 3. **alternatus.**
  - Elytral striæ distinct........................ 4. **seriatus.**
- Lateral groove of rostrum triangular feeble; pronotum neither channeled nor carinate; elytral striæ wanting........................ 5. **simplex.**

The bibliography and localities as follows:

1. T. **didymus** (Lec.), Proc. Ac. Nat. Sc. Phila. vii., 20, (*Alophus*;) Pacific R. W. Expl. and Surv. Insects, p. 54.

Oregon.

2. T. **constrictus** (Lec.), ibid. (*Alophus*); ibid.†; *A. alternatus*‡ Mann., Bull. Mosc. 1843, 290; ib. 1853, 244.

Alaska and Washington Territory. This is very similar to the preceding and may with larger series of specimens prove only a race thereof. The prothorax, however, seems more coarsely punctured, and consequently subserrate at the sides.

3. T. **alternatus.** *Hypsonotus altern.* Say, Curc, 10; ed. Lec. i., 271; *Alophus altern.* Boh., Schönh. Curc. ii., 286.

Lake Superior.

4. T. **seriatus** (Mann.), Bull. Mosc. 1853, 245, (*Alophus*).

Alaska.

5. T. **simplex**, n. sp.

Brownish black, clothed with pale brown prostrate pubescence; head, beak and prothorax densely not coarsely punctured, the latter with a stripe of denser pubescence each side, elytra more finely densely punctured. Length, 8.5 mm.; .32 inch.

Manitoba and Hudson Bay Territory. Smaller than the other species, and easily known by the lateral groove of the beak being shorter, broader, triangular and feebly impressed. The outer two striæ of the elytra are distinct, the others obliterated; the pubescence becomes squamiform on the sides of the prothorax beneath, and on the side pieces of the meso- and metasternum, as in the other species of the genus.

*In *Alophus* the lateral groove is wanting.

Digitized by Google

LOPHALOPHUS n. g.

In this genus the beak is parallel, flat above, not as stout as in the other genera, and the apical wings are not developed; the medial groove is replaced by a fine carina, and the lateral grooves are wanting; the antennal grooves are short, oblique as usual, but becoming wide and obliterated behind; the grooves on the under surface are obsolete. The antennæ are as in *Alophus*, but rather thicker; the second joint of the funiculus, as usual, a little longer than the first. The eyes are scarcely transverse, but distinctly angulated below; the postocular lobes are obsolete, and the prosternal transverse impression scarcely extends on the sides. The elytra and head are finely punctured, and the former has distinct rows of larger punctures; the prothorax is coarsely and densely punctured, not channeled, but with a small, dorsal smooth space. Under surface pubescent.

The only species known to me is

L. inquinatus. *Liophlœus inq.* Mann., Bull. Mosc. 1852, 351.

Alaska; two specimens from Baron Chaudoir. Differs from *Liophlœus* by the mandibles being without apical scar, by the maxillæ not covered by the mentum, and by the ungues being separate, not connate at base. Length 5.5 mm.; .22 inch.

LEPIDOPHORUS Kirby.

This genus is easily distinguished from the others of the sub-family by the beak being a little broader at the tip, with feeble wings, somewhat as in *Alophus;* otherwise, it is cylindrical, and not carinate nor grooved; the antennal grooves are broad and short, directed towards the eyes, which are scarcely transverse, and distinctly angulated below. The scape of the antennæ is longer than in the other genera, extending across the eyes; the first joint of the funiculus is as long as the three following united; 2–7 equal in length, gradually a little thicker; club oval, pointed. Prothorax not lobed in front, only obsoletely impressed at the sides near the tip; rounded on the sides in front, not narrowed behind, scarcely as wide as long. Elytra elongate oval, humeri rounded; striæ well marked, interspaces flat. Front and middle tibiæ slightly curved and mucronate at tip; the hind pair scarcely mucronate, truncate at tip.

1. **L. lineaticollis** Kirby, Faun. Bor. Am. iv. 201; Schön. Curc. vi, 2d, 256; Mann. Bull. Mosc. 1853, 243.

Two specimens from Alaska, not very well preserved. The body is densely clothed with scales and small bristles; the latter arranged in series on the elytra. Length 4.5 mm.; .18 inch.

This is perhaps *Phytonomus trivittatus* Say, Curc. p. 12; ed. Lec. i, 273; but the description is not very definite.

Sub-Family III. ITHYCERIDÆ.

This sub-family is represented by a single species, and is well distinguished from all other Curculionidæ by the following assemblage of characters.

Digitized by Google

Mandibles prominent, not very stout, emarginate at tip, with an inferior cusp; mentum large, quadrate, supported on a broad and short gular peduncle; ligula and labial palpi small. Beak short, rather broad, one-half longer than the head, antennal grooves wanting; eyes small, rounded, convex. Antennæ not at all geniculate. First joint scarcely longer than the second; third longer than the second; 4–8 gradually a little shorter and broader; club small, oval pointed, annulated. Side pieces of mesosternum diagonally divided; epimera not attaining the prothorax; those of metasternum moderately wide, slightly dilated in front. Ventral segments nearly equal in length; sutures straight, well-marked. Front coxæ contiguous, middle coxæ narrowly separated; hind coxæ transverse, narrow, attaining the side margin. Legs moderate in length, slender, tibiæ truncate at tip, with two small terminal spurs; articular surface terminal, well-defined. Tarsi broad, spongy, pubescent beneath; third joint deeply bilobed; claws divergent, armed at the middle with a small acute tooth.

Inner surface of elytra with the usual fold, commencing near the posthumeral sinuosity, running parallel to the margin as far back as the beginning of the apical curvature; apical region very finely scabrous, with a narrow marginal band of very fine golden pubescence.

In this sub-family the Curculionidæ make the nearest approach to the Rhynchitidæ.

ITHYCERUS Sch.

1. I. **noveboracensis** (Forster), Nov. Spec. Ins. 35, (*Curculio*); (Oliv.) Enc. Meth. v, 553; (Gmelin), Syst. Nat. 1798; Horn, Proc. Am. Phil. Soc. 1872, 447; *Rhynchites curculionoides* Herbst, Käfer, vii, 136; pl. 105, f. 1; *Ithycerus curc.* Gyll., Sch. Curc. i, 246; *Curc. punctatulus* Fabr., Ent. Syst. i, 187; Oliv., 83, 402, pl. 10, f. 119; Enc. Méth. v, 533; *Pachyrhynchus Schonherri* Kirby, Faun. Bor. Am. iv, 271.

Canada to Texas; sometimes quite injurious to fruit trees by gnawing off the tender buds, as is observed by C. V. Riley (Third Report Ins. Inj. Missouri, p. 57). The anal segment of the ♂, is very convex and protuberant, so as to be visible from beneath, simulating a ventral segment. We owe the first accurate observation and explanation of this fact to Dr. Horn. The pygidium is deeply grooved in both sexes, and projects beyond the elytra.

Sub-Family IV. CURCULIONIDÆ (genuini).

The species of this sub-family may be recognized by the mandibles being rarely emarginate at tip, but either bi-emarginate, with three apical cusps, or oblique, with three cusps on the inner side, which sometimes become effaced, or obsolete. In the first tribes the inferior cusp is also smaller, and less prominent, but it speedily becomes more developed, and it is by the final dominance of that cusp, with the edge of the mandible which corresponds to it, that the oblique form with the teeth on the inner edge, is assumed; and a still greater prominence of this inferior edge and cusp results in the oblique or flattened form of mandible seen in certain *Cryptorhyn-*

Digitized by Google

chini and *Barini*. From them the transition is easy to the next sub-family Balaninidæ in which the mandibles are still more depressed, and the condyle instead of being on the outer side comes to the upper surface, so that the movement is vertical, instead of horizontal as in all other Coleoptera.

It must also be observed that in certain *Phytonomini* the interior cusp becomes very small or obsolete, so that the mandibles seem to be only emarginate at tip. They thus approach the two preceding sub-families, but are readily known by not possessing the peculiar characters which distinguish each of them. The beak is not short and flat, and the eyes are not round, as in Sitonidæ; the gular margin is not prominent as in Alophidæ; and the antennæ are not straight, nor the claws appendiculate as in Ithyceridæ.

After eliminating the types which seem of sufficient importance to be regarded as having family or sub-family value, there still remains this vast complex, which presents no difficulty in circumscription. It nevertheless comprehends so many diversified combinations and representations of a few simple characters, and under each so many variations in a few definite directions, that much labor, and very careful observation is necessary to devise a scheme which will enable the genera to be naturally grouped, and easily recognized.

I believe that the following table will be found sufficient for the proper elucidation of our limited fauna, and perhaps with a certain amount of expansion and modification, may serve as a basis for a general arrangement of the sub-family.

Front coxæ contiguous [except in *Pissodes* (p. 142), *Phycocœtes* (p. 189), and *Miarus* (p. 221)] .... 2.
Front coxæ distant [except in *Notolomus* (p. 222), and *Conotrachelus* (p. 225)] .... 14.

2. Ungues simple; pygidium not exposed .... 3.
" appendiculate, toothed or cleft, [except in some *Magdalis* (p. 192), and *Cionini* (p 219)] .... 9.

3. Eyes not contiguous beneath .... 4.
" contiguous beneath, (p. 320) .... **HORMOPINI.**

4. Mandibles bi emarginate, and 3-toothed at tip .... 5.
" usually emarginate, 2-toothed at tip, articular surface of at least the hind tibiæ terminal (p. 123) .... **PHYTONOMINI.**

5. Tibiæ fossorial (p. 137) .... **EMPHYASTINI.**
" not fossorial .... 6.

6. Side pieces of metathorax distinct .... 7.
" " indistinct (p. 190) .... **TRACHODINI.**

7. Lateral angles of first ventral segment not visible .... 8.
" " " uncovered (p. 144) .... **CLEONINI.**

7. Mentum transverse, labial palpi large (p. 137) .... **HYLOBIINI.**
" smaller, " " small (p. 160) .... **ERIRHININI.**

9. Ventral sutures straight .... 10.
Ventral sutures angulated at the sides .... 12.

Digitized by Google

10.	Prothorax contiguous to the elytra.	11.
	Prothorax pedunculate (p. 191).	OTIDOCEPHALINI.
11.	Hind angles of prothorax acute (p. 192).....	MAGDALINI.
	" " " " rectangular or rounded (p. 193)................................	ANTHONOMINI.
12.	Funicle six or seven-jointed.	13.
	" five-jointed (p. 219).	CIONINI.
13.	Scape extending upon the eyes (p. 210).	PRIONOMERINI.
	" not extending upon the eyes (p. 211).	TYCHIINI.

14.	Ventral sutures more or less curved..........	14.
	" " entirely straight (p. 223)....	LÆMOSACCINI.
15.	Humeri of elytra truncated by side pieces of mesothorax (p. 284)., ...	BARINI.
	Humeri not truncated.............................	16.
16.	Beak received in or upon the breast..........	17.
	Beak not received in or upon the breast; prosternum very long in front of the coxæ, which are nearly contiguous (p. 221)......	DERELOMINI.
17.	Eyes more or less covered in repose, except in the group *Phytobii* (p. 280)...............	18.
	Eyes not covered..................................	19.
18.	Body oval, pygidium covered (p. 223)........	CRYPTORHYNCHINI.
	" broad, pygidium exposed (p. 267)......	CEUTORHYNCHINI.
19.	Antennæ geniculate, eyes very large (p.259)	ZYGOPINI.
	" straight (p. 265).......................	TACHYGONINI.

Tribe I. PHYTONOMINI.

Among the tribes in which the ungues are simple and separate, and the pygidium not exposed, the present one may be distinguished by the form of the mandibles, and by the hind tibiæ being truncate at tip, with the articular surface terminal, and though somewhat oblique, not lateral as in Hylobiini. It follows from this that the terminal spine representing the spur is situated on the inner side of the apical surface.

The mentum is oblong, and supported on a gular peduncle which is not longer than wide, and emarginate. The ligula and labial palpi are less developed than in Hylobiini; the maxillæ are entirely exposed. The mandibles are short, very stout, pincer-shaped, emarginate at tip, (except in *Phytonomus opimus*) convex and sparsely sculptured on the outer surface, the basal condyle large. Antennæ inserted near the tip of the beak, geniculate; scape long, club elongate-oval, pointed, annulated, covered with sensitive surface; funiculus 7-jointed; the seventh joint in some species connected with the club. Beak moderately long, not slender, antennal grooves extending nearly to the tip, deep, directed towards the lower part of the eyes, which are more or less transverse and narrowed beneath. Front coxæ round; contiguous; middle coxæ round, narrowly separated, entirely en

Digitized by Google

closed by the meso- and metasternum. Side pieces of mesosternum diagonally divided; of the metasternum, narrow dilated in front, the outer angle making a sinuosity in the side margin of the elytra. Ventral segments unequal; first and second longer; third and fourth shorter; fifth as long as the two preceding united; sutures straight; the lateral angles of the first segment are covered by the elytra, and the intercoxal process is broad.

The proportions of the ventral segments permit the recognition of two groups.

A. Ventral segments not very unequal; postocular lobes of prothorax obsolete .... **Phytonomi.**
  Articular surface of hind tibiæ well-defined, terminal. .... **PHYTONOMUS.**
  Articular surface of hind tibiæ ill-defined, oblique... **LEPYRUS.**
B. Ventral segments very unequal; third and fourth short, united equal to one of the others.......... **Listroderi.**
  Tibiæ strongly mucronate; second joint of funiculus much longer than the first.......... **LISTRONOTUS.**
  Tibiæ feebly mucronate; first joint of funiculus as long as, or but little longer than the second....... **MACROPS.**

PHYTONOMUS Sch.

A. Beak short and thick, 1st and 2d joints of funiculus equal.......... **1. opimus.**
B. Beak longer and more slender, 1st joint of funiculus stouter and frequently longer than second:
  Elytra much wider than base of prothorax...... **2.**
  " scarcely " ' " ...... **2. elongatus.**
2. Prothorax pubescent without scales.......... **3.**
  " scaly with long hairs intermixed.......... **3. setigerus.**
  " scaly without hairs, scales very small......... **5.**
3. Pubescence coarse.......... **5. pubicollis.**
  " very fine.......... **4.**
4. Pubescence mottled, elytra tesselated.......... **6. Castor.**
  " pale-green, nearly uniform.......... **7. nigrirostris.**
5. Scales golden-brown, sides of prothorax rounded.. **4. comptus.**
  Scales dirty-gray, sides of prothorax nearly straight **8. quadricollis.**

1. P. opimus, n. sp.

Robust, black, densely finely punctured, and covered with gray scales, having a metallic lustre ; sparsely and indistinctly pubescent. Beak one-half longer than the head, stout, curved, antennal grooves deep, suddenly flexed downwards ; there is a small oblique groove each side near the tip, a short nasal furrow, and another between the eyes which are transverse. The funiculus of the antennæ has the first joint nearly as long as the second, which is nearly equal to the three following united. Prothorax subquadrate, a little wider than long, rounded on the sides in front, and feebly constricted ; disc very obsoletely channeled. Elytra much wider

Digitized by Google

than the prothorax, one-half wider than long, convex, humeri prominent, striæ with large shallow punctures, interspaces somewhat convex, first, third and fifth a little more prominent. Tibiæ not mucronate, not even the front pair. Length 7.6 mm.; .3 inch.

One specimen from Pennsylvania given me by Dr. Melsheimer, under the name adopted; another from Canada. The mandibles are oblique, and not emarginate at tip.

I should refer this species to *Cephalalges*, but the eyes are not approximate above as described in that genus. It belongs, however, to the group *Donus* Capiomont, and seems related to the Canarian *P. irroratus* Wollaston. I am not at all certain that it properly belongs to our fauna.

2. P. elongatus Gyll., Sch. Curc. ii, 374; Schiödte, Berl. Ent. Zeitsch. 1859, 141, Cap. l. c. 1868, 193; *Curculio elong.* Paykull, Fauna Suec. iii, 236.

One specimen from Greenland, kindly sent me by Mr. Chr. Drewsen. Belongs to Capiomont's sixth group *Phytonomus.*

3. P. setigerus, n. sp.

Moderately elongate, black, densely clothed with yellow-brown scales, and long pale hairs, which on the elytra are arranged in rows; prothorax strongly rounded on the sides, widest at the middle, with two broad darker discoidal stripes, and a spot each side in front; elytra with the alternate spaces tesselated with dark-brown, and frequently with a large quadrate common dark spot at the base; first joint of funiculus of antennæ one-half longer than the second. Length 5.5 mm.; .22 inch.

Kansas, two specimens. Larger and stouter than the next, and easily known by the hairs intermixed with the scales, and by the funiculus of the antennæ longer and more slender, with the first joint conspicuously longer than the second.

This species is allied to the European *P. Pollux,* but the prothorax is wider in front and more rounded on the sides, and the setæ of the elytra are much longer and more obvious.

4. P. comptus Say, Curc. 12; ed. Lec. i, 274; Gyll., Sch. Curc. ii, 384; *P. diversus* Gyll., ibid. ii, 371; Cap., Ann. Ent. Fr. 1868, 163.

Missouri and Canada. Has been observed by Mr. Riley to form a cocoon similar to that of European species. Belongs to Capiomont's third group *Erirhinomorphus.*

5. P. pubicollis, n. sp.

Less elongate, blackish, head and prothorax pubescent, with gray hairs, more coarse on the latter; front narrow, with a deep fovea behind the eyes. Prothorax not longer than wide, a little wider at the middle, narrower in front than at base, rounded on the sides; strongly and densely punctured, indistinctly trivittate. Elytra one-third wider than the prothorax, oval, truncate at base, humeri rounded; striæ punctured, clothed with depressed hair-like scales, and a very few intermixed short hairs; gray, tesselated with brown and black; a quadrate dark spot at the base,

Digitized by Google

extending to the second stria, as in *P. setigerus*, and the European *P. Pollux*. Antennæ piceous, first joint of funiculus but little longer than the second. Tibiæ and tarsi testaceous. Length .5 mm.; 20 inch.

Vancouver Island, one specimen. Very like several European species, but easily distinguished by the coarse pubescence of the prothorax unmixed with scales. The last joint of the funiculus is closely attached to the club.

6. P. **Castor**, n. sp.

More elongate, blackish, head and prothorax very finely pubescent with gray hair; front wider, with a fovea behind the eyes. Prothorax a little longer than wide, a little wider at the middle, narrower in front than at base, rounded on the sides, densely punctured, trivittate with white. Elytra one-third wider than the prothorax, oblong oval, humeri rounded, striæ punctured; clothed with very small scales so deeply bifurcated as to resemble fine hairs; also with rows of very short pale setæ; gray, varied with brown, and tesselated with small black spots; the darker quadrate basal spot is not very distinct. Antennæ with the first joint of the funiculus about one-third longer than the second. Legs blackish. Length 5 mm.; 20 inch.

Canada, one specimen. More elongate than the European *P. Pollux*, and easily distinguished by the finely pubescent prothorax and the rows of short setæ of the elytra. The last joint of the funiculus is quite separate from the club. The scales of the elytra are very small and quite peculiar in form, giving the appearance of very fine hairs arranged by pairs.

7. P. **nigrirostris** Gyll., Sch. Curc. ii, 393; Cap., Ann. Ent. Fr. 1868, 227; *Rhynchænus nigr*. Fabr., Syst. El. ii, 428, &c., &c.

This common European species occurs in Canada and in Massachusetts. It belongs to Capiomont's seventh group *Phytonomidius*, in which the first joint of the funiculus is much longer than the second, which is not longer than the third.

8. P. **quadricollis**, n. sp.

Blackish-brown, covered with a very dense coat of dirt colored small rounded scales, mixed with a few very short sub-erect hairs, which form rows upon the elytra. Beak as long as the prothorax, cylindrical, about three times as long as wide, glabrous, and nearly smooth at tip, which is reddish-brown; feebly carinate; frontal fovea small, distinct. Eyes oval transverse, not narrowed beneath, not prominent. Prothorax nearly square, very slightly narrowed in front, sides scarcely rounded, base feebly rounded; sculpture concealed by the scales. Elytra more than half wider than the prothorax, oblong oval; humeri abruptly rounded, sides then parallel, rounded at tip; striæ impressed, punctured, punctures almost concealed by the scales; interspaces nearly flat, third a little more convex. Antennæ brown, first joint of funiculus as long as the two following; second very little longer than the third. Length .5 mm.; .20 inch.

One specimen from Dacota, Mr. E. P. Austin. Very different from the other species by the nearly square prothorax. The ventral segments are

Digitized by Google

not very unequal, and the fifth is but little longer than the fourth, so that it is truly a Phytonomus.

LEPYRUS Sch.

The position of this genus seems to me to have been greatly misinterpreted. Lacordaire has placed it next to *Hylobius*, from which it differs in the form of the mandibles which are emarginate simply, as in *Phytonomus*; in the size and shape of the mentum, which is oblong and rather large; in the development of the ligula and palpi, which are much smaller than in *Hylobius*, and finally in the form of the articular surface of the tibiæ, which is in *Lepyrus* oblique, and in *Hylobius* and allies quite lateral.

In my opinion, *Lepyrus* is a gigantic *Phytonomus*, with scarcely any generic characters to separate it, except the less transverse eyes and the oblique terminal surfaces of the tibiæ. The habits of the species well agree with this view, as they are found on plants, or on the ground, while the *Hylobii* occur only under bark.

Three species occur in our fauna.

Elytral striæ composed of large punctures.................. 2
" " feeble, alternately approximated, interspaces roughly granulate................................. 1. **gemellus.**
2. Elytra finely pubescent with gray hairs, marked each with a white spot .... 2. **colon.**
Elytra thinly clothed with very small yellow scales, each with a yellow spot.................................... 3. **geminatus.**

1. L. **gemellus** Kirby, Faun. Bor. Am. iv, 198, pl. 5, f. 7; Mann., Bull. Mosc. 1852, ii, 351.

Hudson Bay Territory and Alaska.

2. L. **colon** Gyll., Sch. Curc. ii, 330; Boh., ib. vi, 2d, 295; Kirby, Faun. Bor. Am. iv, 197; *Curculio colon* Linn., Mant. 531; cum synon. plur. Europ.

Hudson Bay Territory.

3. L. **geminatus** Say, Curc. 12; ed. Lec. i, 273.

Illinois to Colorado. Differs from *L. colon* by the elytra clothed with small narrow yellow scales instead of fine gray hairs, and also by the elytra being separately acuminate at tip instead of conjointly rounded.

LISTRONOTUS Jekel, Ann. Ent. Fr. 1864, 565.

This genus includes all the larger North American species heretofore classed under *Listroderes*, and a few moderate sized or small species; in some of the latter the beak becomes cylindrical, and only feebly carinate, so that they resemble in appearance *Phytonomus*. They are, however, easily distinguished by the different proportions of the ventral segments; the first, second and fifth being long, and the third and fourth very short. The legs are more slender than in *Phytonomus*, the tibiæ bent inwards at

Digitized by Google

the tip, and tolerably strongly mucronate. The side pieces of the metasternum are narrower than in *Phytonomus* and are strongly produced inwards at the front part. In some of the species I have observed curious sexual characters in the ventral segments, but in others no difference is seen. The metasternum is long, and the species, so far as I know, are winged.

The anal segment of the ♂ is frequently so convex as to project behind the last ventral, so as to become visible from beneath. There is an elongated surface on the inside of the elytra, extending along the margin, for the apical fourth of the length, which is perhaps a stridulating plate. I have found a somewhat similar arrangement in other genera, but the full investigation of the subject must be deferred to another time.

The relations of the antennal joints enable the species to be arranged in two groups:

A. Funiculus of antennæ slender, third joint somewhat longer than the fourth; second joint twice or thrice as long as the first.

Sub-apical callus of the elytra very prominent	2.
" " " " less prominent	4.
" " " " not prominent	5.
2. Beak carinate and sulcate	3.
Beak nearly cylindrical; lateral grooves obsolete	3. **tuberosus.**
3. Elytra with darker oblique mark..................	1. **obliquus.**
" uniform dirty brown..........................	2. **sordidus.**
4. Humeri rounded, base of elytra feebly emarginate	4. **squamiger.**
Humeri oblique, base of elytra deeply emarginate..	5. **callosus.**
5. Elytra obliquely declivous behind..................	6.
" compressed and vertical behind............	8. **americanus.**
6. Humeri rounded..	6. **inæqualipennis.**
" oblique	7. **caudatus.**
Sides of prothorax strongly rounded..............	9. **rotundicollis.**

B. Funiculus of antennæ less slender, third and following joints rounded, equal, second joint nearly three times as long as the first; posterior callus of elytra feeble.

Head clothed with hair-like scales; beak slightly flattened above, more or less carinate and sulcate	2.
Head clothed with rounded scales......................	9.
2. Prothorax distinctly longer than wide...........	3.
" not " " "...........	6.
3. Scales of prothorax smaller than those of elytra	4.
Scales of prothorax larger than those of elytra	10. **appendiculatus.**

Digitized by Google

4. Beak stout, strongly carinate and sulcate.......	11. **sulcirostris**
" as usual, slightly " " "	5.
5. Frontal fovea obsolete ; form more elongate..	12. **nebulosus.**
" " deep ; " less " ..	13. **frontalis.**
6. Prothorax intricately rugose, sub-granulate, with scattered large punctures	14. **oregonensis.**
Prothorax deeply, coarsely and densely punctured	7.
7. Sides of prothorax broadly rounded.............	8.
Sides " strongly "	16. **cribricollis.**
8. Beak feebly carinate and sulcate, frontal fovea faint..	15. **latiusculus.**
Beak strongly carinate and sulcate, frontal fovea deep..	17. **impressifrons.**
9. Setæ of ordinary length	10.
" longer and clavate..................................	18. **setosus.**
10. Frontal fovea deep, punctiform..................	11.
" " obsolete	12.
11. Color mottled..	19. **punctiger.**
" nearly uniform	20. **teretircstris.**
12. Prothorax longer than wide, not vittate.........	21. **gracilis.**
" more rounded and broader, vittate	22. **nevadicus.**

1. L. **obliquus**, n. sp.

Black, densely clothed with small rounded scales, which become larger on the prothorax, and narrower, smaller and hair-like upon the head. Beak as long as the prothorax, stout, slightly curved, carinate, distinctly sulcate at the side; frontal fovea deep. Prothorax nearly square, sides parallel for three-fourths the length; then suddenly rounded and narrowed at the apex; sides and narrower dorsal line pale-brown, disc, flanks and apical spots each side darker; surface with large scattered blackish dots. Scutellum pale. Elytra broadly emarginate at base, humeri oblique, gradually narrowed on the sides, obliquely declivous behind, subapical callus very prominent, conical, obtuse; striæ finely impressed, coarsely punctured, interspaces broad and flat; the scales are brown on the disc from the base for two-thirds the length, and from the suture to the third stria ; also upon the inflexed flanks and near the callus ; elsewhere they are pale-brown, and there is an oblique dark stripe upon the fourth and fifth interspaces in front of the middle ; the setæ are very sparse and short. Beneath the scales are of the darker brown tint, with a few large blackish punctures similar to those upon the prothorax. Length 9.2 mm. ; .36 inch.

♀. Last ventral segment with a short deep channel at the tip ; each elytron prolonged at the apex into a short conical process. ♂ unknown.

Two ♀ ; Texas; Belfrage.

2. L. **sordidus** (Gyll.), Sch. Curc. ii, 280, (*Listroderes*); ? *L. distinguendus* Gyll., ibid. ii, 281.

Digitized by Google

♂. First ventral segment flattened at base; anal segment projecting beyond the last ventral, and visible from beneath; elytra not prolonged at tip.

♀. Last ventral segment feebly channeled at the apex; elytra conjointly prolonged at tip.

Massachusetts to Georgia. Length 8 mm.; .31 inch.

I know not why Gyllenhal placed this species among those in which the third—seventh joints of the funiculus are nodose; they are in reality as slender and subturbinate as in any of his first division. The synonym seems to differ from the type only by smaller size and slightly irregular elytral puncturing; similar variations occur in other species.

3. L. **tuberosus**, n. sp.

Black, densely clothed with yellowish-brown rounded scales, which become larger on the prothorax, and hair-like upon the head. Beak as long as the prothorax, stout, cylindrical, carina and grooves obsolete, frontal fovea feeble. Prothorax as wide as long, sides nearly parallel, suddenly rounded and narrowed near the tip, indistinctly trivittate with pale and sprinkled with large distinct black dots. Scutellum pale. Elytra at base broadly emarginate, humeri oblique, so that they become one-third wider than the prothorax, sides gradually narrowed behind the widest part; posterior callus large, conical, prominent; striæ punctured, interspaces wide nearly flat; scales uniform in color, very dense, setæ very short. Beneath of the same color as above, hind thighs with a pale band. Length 7 mm.; .28 inch.

♂. First ventral segment flattened at base, anal segment protuberant beyond the fifth ventral and visible from beneath; elytra rounded at tip.

♀. Last ventral segment feebly impressed near the tip, each elytron prolonged at tip into a long straight process.

Michigan to Georgia. Easily known by the absence of the carina and grooves of the beak, which are so obvious in the two preceding species.

4. L. **squamiger** (Say), Curc. 11; ed. Lec. i, 271, (*Listroderes*); Gyll. Sch. Curc. ii, 279, Boh., ibid. vi, 189, partim.

♀. Last ventral with two strongly elevated folds at the tip, converging towards the front, but not meeting, presenting the appearance of a deep excavation; pygidium feebly channeled, rather pointed at tip; elytra separately acuminate, but not prolonged at tip; ♂ wanting.

One ♀, Georgia. Length 9.7 mm.; .38 inch. The posterior callus of the elytra is oblong, moderately prominent, but not a conical tuberosity as in the three preceding species, since it graduates imperceptibly into the fifth interspace.

The ♀ mentioned by Boheman in the last citation belongs to this species, the supposed ♂ with caudate elytra is a ♀ variety of *L. inæqualipennis*.

5. L. **callosus**, n. sp.

Blackish, densely clothed, as in the other species, with small rounded scales, becoming larger on the prothorax, and hair-like upon the head,

Digitized by Google

they are dirt colored on the general surface of the body, but pale at the sides of the prothorax and elytra, and on a narrow dorsal vitta of the former. Beak as long as the prothorax, distinctly carinate and sulcate, prothorax scarcely as wide as long, broadly rounded on the sides, gradually narrowed in front of the middle, marked as usual with scattered black dots. Scutellum pale. Elytra strongly emarginate at base, humeri oblique; striæ strongly punctured, interspaces wide, somewhat convex; posterior callus rather prominent, oblong, fading in front into the fifth and adjoining interspaces. Beneath dirty brown speckled with black punctures. Length 9–10.5 mm.; .35–.42 inch.

♂. Last ventral segment not impressed, anal segment very slightly visible behind the last ventral.

♀. First and second ventrals with a broad shallow impression, last ventral with a deep round excavation extending from the base to the tip; pygidium semi-circularly emarginate at tip; elytra separately subacuminate at tip.

New York to Georgia. The posterior callus of the elytra is about as prominent as in *L. squamiger*, but not so narrow.

6. L. **inæqualipennis** (Boh.), Sch. Curc. vi, 189, (*Listroderes*).

♂. Ventral segments first and second broadly concave at the middle, fifth not impressed, anal segment convex and protuberant behind the last ventral; elytra conjointly rounded at tip.

♀. Last ventral with two strongly elevated folds at tip, converging anteriorly but not meeting, leaving between them a deep excavation; pygidium somewhat pointed at tip; elytra separately prolonged at tip into a long straight pointed process.

Middle and Southern States. Closely allied to the next, but easily distinguished by the sexual characters and by the elytra being but slightly emarginate at base, with rounded humeri, as in *L. squamiger*. Length 7–11 mm.; .275–.43 inch.

7. L. **caudatus** (Say), Jour. Ac. Nat. Sc. Phila. iii, 311; ed. Lec. ii, 174, (*Rhynchænus*); Gyll., Sch. Curc. ii, 278 (*Listroderes*).

♂. Last ventral segment not impressed, anal segment slightly visible behind the last ventral, elytra rounded at tip.

♀. Last ventral broadly but feebly concave towards the tip; pygidium not pointed at tip; elytra separately prolonged into apical processes which converge at tip.

Western States.

8. L. **americanus**, n. sp.

Blackish, covered with round dirty-brown scales, becoming larger on the prothorax, less dense and hair-like upon the head and beak. Beak as long as the prothorax, strongly carinate and sulcate. Prothorax scarcely as long as wide, rounded on the sides, narrowed before the middle, constricted towards the tip; marked with two sinuous lateral vittæ, and a scarcely distinct dorsal line of pale scales. The punctures are less concealed by scales

Digitized by Google

than in the species above described, and are very coarse and dense. Scutellum pale. Elytra strongly emarginate at base, humeri oblique, sides then parallel, rounded behind; the posterior callus is distinct, not very prominent; the elytra are compressed at the suture towards the tip, and vertically declivous; the striæ are strongly punctured, the interspaces somewhat uneven; there is an indistinct broad stripe commencing at the humeri and running backwards on the sixth, seventh, and eighth interspaces, and there are besides some irregular mottlings of pale scales. Beneath punctured, irregularly spotted with large pale scales; thighs with a pale band. Length 14 mm.; .55 inch.

♀. Last ventral deeply concave, the excavation smooth at the bottom, and transversely impressed with a short line, becoming narrow at the tip, which is deeply emarginate; the upper marginal line is continued around the tip, separate from the lower one, and the space between them is curiously and deeply marked with two excavations on each side near the extreme emargination; pygidium strongly emarginate; tips of the elytra separately rounded. ♂ wanting.

Georgia, three specimens. I have seen nothing similar to the curious sculpture of the last ventral segment, though in its homology it is only a modification and complication of the forms mentioned under other species. It is the *Eudocimus americanus*‡ Dej. Cat. 299, but bears no resemblance to *Eu. Mannerheimii.*

9. L. **rotundicollis**, n. sp.

Blackish, covered with the usual scales, of a dirty-brown; beak feebly carinate, lateral grooves almost obsolete; frontal fovea distinct. Prothorax as wide as long, sides strongly rounded, clothed with paler scales; surface coarsely and densely punctured; an indistinct paler dorsal stripe may also be traced. Elytra with deep punctured striæ, and convex interspaces; posterior callus obsolete. Length 7.5 mm.; .30 inch.

♀. Last ventral with a large shallow rounded impression; elytra conjointly rounded at tip. ♂ wanting.

One ♀, Georgia. Quite distinct by the more rounded prothorax. The funiculus of the antennæ is as slender as in any of the preceding species; the setæ of the elytra are rather more conspicuous.

10. L. **appendiculatus** (Boh.), Sch. Curc. vi, 2d, 192, (*Listroderes*).

♂. Elytra conjointly rounded at tip.

♀. Elytra separately produced into a short straight process.

Canada to Texas. More elongate than any other species in which the beak is flattened and subcarinate. Length 4.2–6.5 mm.; .16–.25 inch.

11. L. **sulcirostris**, n. sp.

Elongate, black, less densely covered with small, rounded, dirty brown scales, no larger on the prothorax. Beak stouter than usual, with the ridges and grooves so strongly marked as to appear tricarinate and quadrisulcate. Prothorax longer than wide, sides nearly straight for two thirds the length, then gently rounded to the apex; punctures dense, unequal, the larger ones

Digitized by Google

more distant. Elytra broadly emarginate at base, one-fourth wider than the prothorax, humeri rounded; striæ strongly punctured, interspaces slightly convex, conjointly rounded at tip in both sexes. Length 8 mm.; .32 inch.

♂. Last ventral not impressed.

♀. " " with a broad, shallow impression.

One pair of partially abraded specimens: Georgia. Easily known by the stouter and more deeply sculptured beak, and stouter antennæ; otherwise it resembles *L. nebulosus* in form.

12. **L. nebulosus**, n. sp.

Elongate, blackish, clothed with scales, mottled brown and dark, on the head with a metallic lustre. Beak feebly carinate and sulcate as usual. Prothorax longer than wide, sides feebly rounded for two-thirds the length, then more rounded to the tip; scales small, a bifurcated lateral vitta, and an interrupted dorsal line paler; punctures dense and deep. Elytra about one-fourth wider than the prothorax, strongly emarginate at base, humeri oblique, slightly rounded; striæ strongly punctured, interspaces wide and flat. Thighs with a pale band. Length 9.5 mm.; .375 inch.

♀. Last ventral slightly impressed; elytra conjointly rounded at tip.

One ♀, Missouri. Easily recognized by the elongate form and mottled color.

13. **L. frontalis**, n. sp.

Blackish, less elongated, covered with rounded scales, which are no larger on the prothorax; these scales are dirty brown on the elytra, and with a metallic lustre on the head and prothorax. Beak finely carinate, lateral grooves almost obsolete, frontal fovea deep. Prothorax very little longer than wide, broadly rounded on the sides, transversely impressed near the tip; lateral stripes and dorsal line indistinctly paler, punctures dense, of two sizes, the larger more distant. Elytra one-third wider than the prothorax, broadly emarginate at base, humeri rounded; striæ strongly punctured, interspaces wide, nearly flat; tip conjointly rounded in both sexes. Length 5.7–10 mm.; .23–.40 inch.

♂. Last ventral not impressed; anal segment slightly prominent.

♀. Last ventral with three shallow impressions.

Michigan, New York, Georgia, Texas. Stouter than *L. nebulosus*, and easily recognized by the above characters. The setæ of the elytra are more obvious than usual.

14. **L. oregonensis** Lec., Pac. R. R. Expl. and Surv. Ent 55.

One abraded ♀ from Oregon. The last ventral segment is not at all impressed. The beak is feebly carinate, and obsoletely sulcate, the frontal fovea not deep. The prothorax is a little wider than long, much rounded on the sides, and feebly channeled, the sculpture is peculiar, consisting of small granules, separated by deep rugosities, and mixed with large, scattered punctures; on each granule is a small puncture; the few scales which remain are small, and indicate three paler stripes. The elytra are one-third

Digitized by Google

wider than the prothorax; the humeri are rounded, and the base slightly emarginate; striæ strongly punctured, interspaces slightly convex. Length 6 mm.; .23 inch.

15. L. **latiusculus** (Boh.), Sch. Curc. vi. 2d. 199.

I refer this name to a species which occurs in the Middle and Southern States, and is by no means rare. The form is less elongate than in *L. appendiculatus*, and the prothorax is a little wider than long, slightly narrowed in front, and feebly rounded on the sides; the punctures, on removal of the scales, are large, deep and densely placed; the scales are of the usual dirt color, not conspicuously varied in color, though the prothorax is indistinctly trivittate, and larger upon the prothorax than upon the elytra. Elytra about one-third wider than the prothorax, slightly emarginate at base, humeri appearing rounded when viewed from above, but oblique when viewed from the front; striæ strongly punctured, interspaces slightly convex; setæ short, tip conjointly rounded in both sexes. The last ventral segment is not impressed in ♀. Length 5—6 mm.; .20—.24 inch.

16. L. **cribricollis**, n. sp.

This species agrees in form, color and sculpture with the preceding, except that the prothorax is very distinctly wider than long, and more strongly rounded on the sides; it is distinctly constricted near the tip, so that looking from above, the postocular lobes appear more prominent. The humeral angles of the elytra are more distinctly oblique. Length 6.7 mm.; .27 inch.

♀. Last ventral with a large round impression, the bottom of which is shining and nearly smooth.

One ♀, Georgia. In this as in the preceding species, the beak is but faintly sulcate, and the middle carina is slightly marked; the frontal fovea is small, and feebly impressed.

17. L. **impressifrons**, n. sp.

This species entirely resembles *L. latiusculus*, in form and sculpture, but the beak is stouter, more distinctly carinate and sulcate, and the frontal fovea is large and deep. The last ventral is not impressed in ♀. Length 5.8 mm.; .23 inch.

Two specimens, Georgia and Louisiana. The prothorax is very deeply and coarsely punctured, and the sides are broadly rounded.

18. L. **setosus**, n. sp.

Blackish, covered with a dense crust of dirty gray and brownish round scales, larger upon the prothorax, and not becoming hair-like upon the head. Beak moderately tricarinate and quadrisulcate. Prothorax distinctly wider than long, sides suddenly rounded near the base and apex. Scutellum pale. Elytra not much wider than the prothorax, slightly emarginate at base; humeri rounded, striæ punctured, interspaces slightly convex, with rows of clavate bristles longer and more evident than the setæ of the other species; tip conjointly rounded in both sexes.

♂. Last ventral slightly impressed at the tip.

♀. Last ventral deeply impressed at the tip.

Digitized by Google

Florida and Georgia: Messrs. Hubbard and Schwarz. Very easily recognized by the scaly head and long clavate bristles.

19. L. **punctiger**, n. sp.

Elongate covered with small round scales of brownish gray and brown mottled, and slightly pearly, not larger on the prothorax, and but little smaller on the head. Beak cylindrical, neither carinate nor sulcate; frontal fovea punctiform deep. Prothorax longer than wide, scarcely narrower in front, broadly rounded on the sides, with a wide lateral pale stripe, which is bifurcated in front; the sculpture is concealed by the scales, but as usual a few large scattered punctures are seen. Scutellum pale. Elytra nearly one-half wider than the prothorax, humeri oblique and slightly rounded, base broadly emarginate; striæ strongly punctured; interspaces wide nearly flat, setæ quite obvious, but not stouter than usual; tip conjointly rounded. Last ventral segment not impressed. Antennæ and legs dark brown. Length 5.7 mm.; .23 inch.

Dacota: one specimen. This species and the next are more elongated in form than any others here described, except *L. appendiculatus*.

20. L. **teretirostris** Lec. Pac. R. R. Expl. and Surv. Ent. 55.

San Francisco, Cal. Precisely similar in form to the preceding. but the beak is a little stouter and very feebly carinate and sulcate; the frontal fovea is punctiform, but not so deep; the scales are of a uniform pale mud color, with slight metallic lustre, and are scarcely mottled with darker. The last ventral segment is impressed at the tip.

21. L. **gracilis**, n. sp.

Precisely similar to *L. teretirostris* in form, size and color, but the beak is more slender, as in *punctiger*, and neither carinate nor sulcate; it differs from both by the absence of the frontal fovea. The prothorax is entirely uniform in color, and the elytra slightly mottled towards the tip. Length 5.3 mm.; .21 inch.

One specimen, Nevada: E. P. Austin. The last ventral is feebly impressed at tip, as in the preceding.

22. L. **nevadicus**, n. sp.

Less elongate, covered densely with dirt colored scales, without lustre. Head covered with smaller scales, beak cylindrical, very feebly carinate and sulcate, frontal fovea wanting. Prothorax not longer than wide, more rounded at the sides, and slightly constricted in front; narrow lateral stripes, and a dorsal line of paler scales. Elytra one-third wider than the prothorax, broadly emarginate at base, humeri rounded, striæ punctured, interspaces wide, nearly flat, setæ as in the three preceding species. Last ventral segment impressed at the tip. Length 4 mm.; .16 inch.

Nevada, E. P. Austin: three specimens. Quite distinct from *L. gracilis* by the less elongate form and more rounded sides of prothorax. The sculpture of the prothorax is concealed by the scales as usual, so that I cannot compare it as fully as I desire with *L. oregonensis*, which it resembles in form. The latter, however, has the last ventral not impressed (♀), and has probably the head clothed with hair-like and not round scales.

Digitized by Google

I have one specimen of the same, or a very similar species from Texas, sent by Belfrage. The scales are, however, in great part abraded, and although I perceive some differences, I am unwilling to indicate it as distinct.

MACROPS Kirby.

The smaller species placed by Schönherr in *Listroderes* were separated by Mr. Jekel as a distinct genus, *Hyperodes* (Ann. Ent. Fr. 1864, 566), and undoubtedly the separation is a proper one. I find, however, that the two species upon which Mr. Kirby founded his genus *Macrops* (Fauna Bor. Am. 199), belong to the same set, and that name must therefore have precedence.

This genus is easily distinguished from the preceding by the tibiæ being stouter and less strongly mucronate at tip, and by the first joint of the funiculus being stouter and as long as the second, except in *M. solutus*, where it is about two-thirds as long as the second; the seventh joint of the funiculus is wider than the sixth, but is quite distinct in most of the species, though in others it is rather closely connected.*

It will be seen that in the characters by which this genus differs from *Listronotus* it approaches *Phytonomus*. The greatest differences will be found, however, in the proportion of the ventral segments, which in the last named genus are not very unequal, while in *Macrops* the third and fourth are very evidently shorter, and together are not longer than each of the others.

The species are closely allied and difficult to distinguish. The descriptions of Boheman and Gyllenhal, though minute, are not sufficient to enable me to identify their species with reasonable certainty, and I therefore content myself with giving a list of those named in the books with references, awaiting more abundant material and comparison with the described types for a proper tabulation of the species:

1. **M. delumbis** (Gyll.), Sch. Curc. ii., 283.
2. **M. lineatulus** (Say), Curc. ii; ed. Lec. i, 272; (Boh.), Sch. Curc. vi, 2d, 195.
3. **M. sparsus** (Say), Curc. ii; ed. Lec. i, 271; (Gyll.), Sch. Curc. ii, 282; *Listr. squalidus* Gyll., ibid. ii, 181.
4. **M. spurcus** (Boh.), Sch. Curc. vi, 2d, 196.
5. **M. immundus** (Boh.), Sch. Curc. vi, 2d, 198.
6. **M. humilis** (Gyll.), Sch. Curc. ii, 284; *M. maculicollis* Kirby, Faun. Bor. Am. iv, 200; pl. 8, f. 4.
7. **M. porcellus** (Say), Curc. ii; ed. Lec. i, 271; (Gyll.), Sch. Curc, ii, 284.
8. **M. vittaticollis** Kirby, Faun. Bor. Am. iv, 200.
9. **M. solutus** (Boh.), Sch. Curc. vi, 2d, 197.

* The anal segment of the ♂ is usually protuberant; the last ventral is impressed in some ♀♀, but never very deeply. The form of the beak, the size of the scales, and the length of the setæ afford good characters for the recognition of many of the species, of which there are probably fifteen to seventeen in my collection.

Digitized by Google

In this species, which is easily known by the denuded transverse black spot, sometimes becoming a band, about the middle of the elytra, the second joint of the funiculus is longer than the first, and the tibiæ are more slender and more bent at the tip than in the others, thus establishing a passage to *Listronotus*.

Tribe II. EMPHYASTINI.

This tribe is evidently closely related to *Hylobiini*, and agrees with it in the structure of the mouth, but differs from it, as from all other tribes in our fauna, by the peculiar form of the tibiæ, which are fitted for digging.

The front tibiæ are compressed, slender, sub-sinuate, prolonged beyond the articulation of the tarsus into a broad process, rounded at tip, and concave beneath ; the spur is small and straight ; the middle tibiæ are roughly tuberculate and setose, with the apical margin repand, dilated on the outer side, and armed with a straight fixed spur at the inner side; the hind tibiæ are bent outwards, tuberculate and setose; much thickened towards the tip, with very large and acutely margined corbels. Tarsi sparsely setose beneath, and not spongy; third joint not dilated nor bilobed ; fourth joint moderate in size, claws slender, simple and divergent.

The antennæ are geniculate ; funiculus 7-jointed; first joint longer ; 2–7 gradually broader, forming a perfoliate stem uniting with the club, which is oval, annulated and pubescent. Beak stout, shorter than the prothorax, deeply grooved; antennal grooves extending to the eyes, which are small, nearly round, and coarsely granulated.

Prosternum not emarginate beneath; front coxæ contiguous, middle ones slightly separated, metasternum short, side pieces narrow, hind coxæ rather large, oval, widely separated, extending to the elytral margin. Thighs stout, unarmed. Ventral segments unequal; third and fourth united equal to the second or fifth; sutures straight, the first obliterated at the middle.

The above characters are drawn from *Emphyastes*. The Australian genus *Aphela* only differs by the legs being less stout ; the tibiæ less expanded or thickened towards the tip, and by the beak not being grooved.

EMPHYASTES Mann.

1. **E. fucicola** Mann., Bull. Mosc. 1852, ii, 354; Lec., Pac. R. W. Expl. & Surv. Ins. 57, pl. 2, f. 8; Lacordaire, Gen. Col. Atlas. pl. 71, fi. 5.

Sea Coast of the Pacific, from Alaska to San Diego; under sea-weed cast up by the waves. The figure of the antenna given by Lacordaire is very incorrect.

This species varies greatly in size, but I have observed none intermediate between the large and small varieties. Length 4.8–6 mm.; .19–.24 inch.

Tribe III. HYLOBIINI.

The mandibles in this tribe have two apical teeth, of which the lower one is a little shorter ; there is besides a cusp on the inner edge, so that they becomes three-toothed. This normal form is preserved through many

Digitized by Google

of the following tribes, modified only by the greater development of the inferior edge and cusp, which by assuming more prominence gives finally an oblique form to the mandible. The gular peduncle is longer than wide, a little wider in front, truncate anteriorly; the mentum is transverse, not large, and the palpi are rather more developed than in the following tribes. The beak is rather long, not slender, except in *Pissodes*, and the antennal grooves do not extend to the tip. Eyes transverse. The antennæ are geniculate; scape long, funiculus 7-jointed, club oval, pointed, annulated, entirely pubescent and sensitive, except in *Pissodes*, where the first joint is smooth and sub-glabrous.

The front coxæ are contiguous and the cavities confluent, except in *Pissodes*, where they are slightly separated. The middle coxæ are not widely separated; the side pieces of metasternum diagonally divided, with the epimera triangular, not attaining largely the base of the prothorax. Side pieces of metasternum narrow, slightly dilated in front. Hind coxæ widely separated, attaining the lateral margin, or nearly so.

Ventral segments unequal, first, second and fifth longer; sutures straight and deeply impressed, except the first which is finer and sometimes slightly sinuate. Pygidium covered by elytra.

Legs stout, or strong; tibiæ armed with a strong hook at tip; articular face lateral; terminal edge of hind tibiæ double, except in *Pissodes;* tarsi with third joint dilated, spongy beneath; claws simple, divergent.

The species are of moderate size, never very small, and are sub-cortical in their habits; they mostly infest coniferous trees.

This tribe leads directly to the Erirhinini, from which they differ chiefly by the less delicately organized mouth, and generally stronger and coarser structure, and by the double edge or corbel to the terminal margin of the hind tibiæ. This character, common in Otiorhynchidæ, now reappears for the last time in the present family.

These corbels are very large and wide in *Pachylobius*, but narrow in the other genera.

Mesosternum moderately long	**2.**
" very short	**Plinthus.**
2. Front coxæ contiguous	**3.**
" " slightly separated	**Pissodes.**
3. Thighs clavate, strongly toothed	**4.**
" feebly clavate, not toothed	**6.**
4. Tibiæ of usual form	**5.**
" short and very thick	**Pachylobius.**
5. Body with spots of fine pubescence	**Hylobius.**
" " " small scales	**Hilipus.**
6. Eyes small, elytra oval, convex	**Hypomolyx.**
" larger, elytra elongate, parallel	**Eudocimus.**

PLINTHUS Germ.

A single species of this genus, which is easily recognized by the very short metasternum, occurs in Oregon and Alaska. It is very roughly

Digitized by Google

sculptured and tuberculate. The thighs are slightly clavate, sinuate beneath near the tip, and armed with a small tooth. The tibiæ slightly curved, not very stout, not compressed, strongly sinuate on the inner side, and serrate from the middle to the tip. The first joint of the funiculus is longer than the second; 2–7 gradually a little stouter, rounded in form; club small, oval pointed, pubescent.

1. **P. carinatus** Boh., Sch. Curc. vi, 334; Mann., Bull. Mosc. 1852, 352; *Heilipus scrobiculatus* Mann., ibid. 1843, 292, (♀).

The ♂ is smaller and narrower than the ♀ and has the abdomen broadly and deeply concave in front. The color is blackish brown, and in well preserved specimens the elytra are mottled with spots of yellow-brown small narrow hair-like scales. Length 6–9 mm; .24–.43 inch.

HYPOMOLYX n. g.

Body elongate, ovate, broader behind, proportioned nearly as in the Alophidæ (*Thricalophus*). Beak as long as the prothorax, rather stout, slightly curved, coarsely punctured with deep triangular anteocular groove at the side, and three faint carinæ above; antennal grooves extending to the lower edge of the eyes, which are transverse, rather small, and not very finely granulated. Prothorax without postocular lobes, prosternum broadly emarginate in front, and fringed with long yellow ciliæ. Mesosternum as long as the first ventral segment. Ventral segments less unequal than in the other genera; fifth but a little longer than fourth; first suture obtusely angulated at the middle. Thighs scarcely clavate, sinuate beneath near the tip, not toothed; tibiæ slender, feebly sinuate on the inner side, armed with a strong apical hook. The first and second joints of the funiculus are elongate and equal, 3–6 rounded, shorter; seventh broader and larger, almost forming part of the club, though less so than in *Hylobius*.

1. **H. pinicola.** *Hylobius pinicola* Couper, Trans. Lit. and Historical Soc. Quebec, 1864.

Lake Superior, Hudson Bay Terr., Canada. Mentioned by me in Agassiz Lake Superior, as *Hylobius heros*, but not described. A fine species, with the prothorax rather small, sub-serrate on the sides, very coarsely punctured, thinly clothed with coarse hair, carinate in front; the elytra densely punctured, mottled with small spots of yellow hair; striæ composed of large elongate deep punctures. Length 13.5 mm; 5.3 inch.

PACHYLOBIUS n. g.

I have separated as a distinct genus *Hylobius picivorus*, which differs greatly from the other species by the tibiæ being much shorter and stouter, and expanded at the tip, so that the corbels or surface included by the double edge on the outer apical margin is much wider than in the other genera of the tribe. The beak is as long as the prothorax, rather stout, not curved, feebly sulcate in front of the eyes, antennal grooves attaining the middle

Digitized by Google

of the eyes, which are large, transverse, and not finely granulated. Antennæ stout, funiculus with rather short joints, becoming gradually broader, seventh forming part of the club, first and second joints very little longer than the following ones. Mesosternum a little longer than the first ventral, which is longer than the second; first suture broadly angulated at the middle. Thighs clavate, very strongly toothed. Prosternum broadly emarginate in front, and fringed with long yellow ciliæ; postocular lobes feeble. Legs stout, thighs clavate, sinuate beneath, and armed with a large tooth; tibiæ suddenly dilated, strongly sinuate on the inner side above the middle and expanded at tip, corbels broad, smooth, lateral terminal hook very large. Mandibles quite different in form from those of the other genera, flattened, so that the tooth which is inferior in the other genera becomes anterior; the under surface is slightly concave, the upper one feebly convex, and the inner margin is obtusely 3-toothed.

1. **P. picivorus** *Liparus pic.* Germ., Ins. Nov. 311; *Hylobius pic.* Boh., Sch. Curc. ii, 340.

Abundant under pine bark, in the Southern States, less frequent in the Middle States.

HYLOBIUS Sch.

The genus as here restricted, will contain only those species in which the mandibles are normal in form, the antennæ stout, with the seventh joint of the funiculus broader and forming part of the club; the eyes are rather large and transverse; the anteocular grooves are broad and shallow. The postocular lobes are large, and the prosternum deeply emarginate in front and fringed. The metasternum is as long as the first ventral. The thighs are clavate, sinuate beneath and strongly toothed; tibiæ slender, sinuate on the inner side, corbels narrow; terminal hook strong. The second and fifth ventral segments are each as long as the third and fourth united, and the first suture is broadly angulated at the middle.

1. **H. pales** Boh., Sch. Curc. ii, 340; *Curculio pales* Herbst, Käfer, vii, 31; pl. 99, f. 10; *Pissodes macellus* Germ., Ins. Nov. 319; Harris, Ins. Inj. beg. ed. ult., 70, (larva).

Lake Superior to Florida, abundant under pine bark. The head is very densely, though not coarsely punctured, and is nearly opaque; the prothorax is coarsely and rugosely punctured. The pubescence of the elytral spots is sometimes yellow, sometimes gray. Length 6.8–10.2 mm.; .27–.4 inch.

2. **H. confusus** Kirby, Fauna Bor. Am. iv, 196.

Lake Superior. Closely resembles the smaller varieties of the preceding, but the head is shining, and less densely and rather more coarsely punctured. The punctures of the prothorax are also less confluent, and the surface less plicate. The pubescence is nearly white. Length 6.8 mm.; .27 inch.

3. **H. assimilis** Boh., Sch. Curc. ii, 345.

Unknown to me; described as larger than *H. pales* with the head dis-

Digitized by Google

tantly punctured, and the elytra without spots of pubescence. Perhaps identical with *H. confusus*, in which case the name has precedence.

4. **H. stupidus** Boh., Sch. Curc. ii, 339.

Georgia. Unknown to me; quite distinct by the narrow and feebly punctured elytral striæ.

HILIPUS Germ.

This genus, largely developed in tropical America, is represented by a single rare species found in Georgia and Florida. Except that the species of this genus are mottled with spots of very small white scales, not hairs, and that the seventh joint of the funiculus is not connected with the club, the differences between it and *Hylobius* are rather comparative than absolute.

The beak is cylindrical, and more curved, without anteocular grooves; the antennal grooves terminate at a greater distance from the mouth; the eyes, postocular lobes and emargination of the prosternum are similar. The thighs are equally clavate, and sinuate beneath, but the tooth is much larger and broader; the tibiæ are compressed, bent inwards, equally strongly armed with a terminal hook, but much less sinuate on the inner side. The first ventral suture is deeper, and more strongly angulated at the middle. The sculpture is much coarser and sparser, and the spaces between the large punctures are smooth and polished.

H. squamosus (Lec.), Ann. Lyc. Nat. Hist. New York, i, 171; pl. xi, f. 101 (*Pissodes*); Boh., Sch. Curc. iii, 161.

Georgia and Florida, under pine bark. A beautiful black insect, with a broad white lateral vitta on the prothorax, and a very irregular one on the elytra, with many scattered small spots, densely clothed with depressed, very small, round, chalky white scales. Punctures of elytra very large, distant, interspaces smooth, shining, except where covered with scales. Length 14.4 mm.; .57 inch.

EUDOCIMUS Sch.

The beak in this genus is cylindrical, nearly straight and as long as the prothorax; there are no anteocular grooves; the antennal grooves reach the middle of the front margin of the eyes, which are large and transverse. The first and second joints of the funicle are elongated and equal; 3–7 shorter, gradually a little wider, club elongate oval, annulated pubescent. Prosternum fringed in front and broadly emarginate, postocular lobes broad. Metasternum as long as the first ventral; third and fourth ventrals together equal to the second or fifth; first suture nearly straight. Legs slender, thighs unarmed, tibiæ straight, not compressed, armed with a strong terminal hook.

Eu. Mannerheimii Boh., Sch. Curc. iii, 241.

New York to Georgia: rare. A conspicuous species of elongate form, clothed with small brown scales; the prothorax striped with pale, and the elytra with conspicuous pale spots on the fourth interspace, which is also clouded with black. Length 10.5—.15 mm.; .41—.6 inch.

Digitized by Google

PISSODES Germ.

The species of this genus have almost the appearance of small *Hylobius*, but differ remarkably by the following characters:

The beak is more slender, cylindrical, without anteocular grooves; eyes small, nearly round; antennæ with the funiculus more slender, and the greater part of the club shining, sparsely pubescent, and destitute of sensitive surface, not distinctly annulated; prosternum not emarginate in front, without postocular lobes. Metasternum as long as the first ventral; third and fourth ventrals together shorter than second; first suture obliterated at the middle and widely angulated. Front coxæ slightly separated by the prosternum; legs rather slender, thighs not toothed, tibiæ straight, slightly compressed, terminal hook strong, but proceeding rather from the outer than inner part of the apex of the tibiæ; corbels wanting.

I am not satisfied with the position of this genus, and am disposed to believe that it should be placed as a separate tribe. Thomson (Skand. Col. vii, 218) associates it with *Trachodes*, but there does not appear to me any resemblance between the two. The definition of his tribe *Pissodina* does not at all apply to *Trachodes*, in which the metasternum is very short, and the club of the antennæ entirely pubescent and sensitive.

These insects live under bark of pine trees, and are sometimes very injurious. There are evidently several species in our fauna, but the differences are not very obvious, and it is quite possible that a careful comparison with foreign species might reduce the number now recognized as distinct.

Prothorax broader than long, more suddenly narrowed in front, and more strongly constricted, slightly bisinuate on the sides; dorsal carina distinct; alternate interspaces of the elytra more elevated............	2.
Prothorax not broader than long, more gradually narrowed in front, and feebly constricted; broadly rounded on the sides, dorsal carina variable..........	3.
2. Elytra with a broad posterior transverse band of yellow pubescence, becoming white towards the suture; prothorax less coarsely rugosely punctured..	1. **strobi.**
Similarly colored; prothorax more coarsely and less rugosely punctured; alternate interspaces more distinctly elevated	2. **costatus.**
Prothorax more densely, less rugosely punctured, outer striæ of elytra less distinct..............................	3. **fasciatus.**
3. Hind angles of prothorax rectangular......................	4. **affinis.**
" " " obtuse............................	5. **dubius.**
" " " rounded......	6. **rotundatus.**

1. P. **strobi** Peck, Mass. Agr. Journ. 1817, iv, 205, (*Rhynchænus*); Say, Curc. 14; ed. Lec. i, 227; Harris, Ins. Inj. Veg. ed. ult., 72; *Pissodes nemorensis* Germ., Ins. Nov. 318.

Digitized by Google

Lake Superior to Georgia. I can see no reason for considering the two names to represent distinct species, as has been done by Gemminger and Harold, and by Crotch.

2. **P. costatus** Mann., Bull. Mosc. 1852, ii, 363.

Alaska and Oregon. A beautifully preserved specimen from California, which I refer to this species on account of its form and sculpture, has the sides of the prothorax clothed with snow-white scales, and the posterior band of the elytra very broad, becoming white towards the suture, just as in the preceding species. In the other species the scales seem to be all yellow, and the markings much smaller.

3. **P. fasciatus**, n. sp.

Blackish-brown, thinly sprinkled with yellowish hairs and small scales; beak strongly punctured, slender, not carinate; prothorax not wider than long, gradually narrowed in front, broadly rounded on the sides, distinctly broadly constricted at tip, hind angles rectangular; disc densely and confluently punctured, obsoletely carinate, sides clothed with yellow scales, narrow dorsal line and four small spots in the usual position yellowish; elytra with a broad band before and another behind the middle yellowish, the latter whitish towards the suture; inner striæ deeply and irregularly punctured, outer ones less distinct, interspaces densely rugosely punctured, third and fifth slightly prominent. Length 7–9 mm.; .28–.35 inch.

Two specimens, Oregon. Seems to differ from *P. strobi* chiefly by the thorax being longer, less coarsely punctured, and less rounded on the sides; by the beak being somewhat stouter, and by the elytral bands more transverse and less oblique towards the sides.

4. **P. affinis** Randall, Bost. Journ. Nat. Hist. ii, 24.

Lake Superior, Canada, and New Hampshire. Distinct from the preceding species by the prothorax narrower, and less constricted in front; from the two following species by the hind angles being rectangular. The disc of the prothorax is coarsely and somewhat rugosely punctured, much as in *P. costatus*, but the striæ are composed of larger punctures, and the interspaces are quite flat. The scales are all cream color, and the posterior band is narrow and imperfect.

5. **P. dubius** Randall, Bost. Journ. Nat. Hist. ii, 24.

Same range as the preceding, from the smallest specimens of which it differs chiefly by the sides of the prothorax converging a little near the hind angles, which thus become somewhat obtuse. There is also some difference in the scales on the elytra, which in well-preserved specimens are more diffused, with the markings less defined.

6. **P. rotundatus**, n. sp.

This species quite resembles in size and form *P. dubius*, except that the sides of the prothorax are more rounded behind, so that the basal angles become still more obtuse and rounded. The prothorax is more densely punctured, and the alternate interspaces of the elytra are slightly elevated;

Digitized by Google

the transverse white spot behind the middle is small, and placed nearer the middle than in the other species. Length 5.7 mm.; .225 inch.

One specimen, Lake Superior.

Tribe IV. CLEONINI.

The character which distinguishes this from all neighboring tribes, is that the elytra are less extended on the flanks of the metathorax and abdomen, so that the lateral angles of the first ventral segment become visible.

The body is never very stout, and frequently is almost linear. The gular peduncle is sometimes short, sometimes long, emarginate at tip; mentum large, flat; ligula feebly or not prominent; palpi much less developed than in *Hylobiini*. Tibiæ more or less mucronate at tip; articular surface lateral; corbels wanting; claws connate at base, or at least approximate. Antennæ sometimes feebly geniculate; joints of funicle gradually broader; club elongate oval, annulated, pubescent and sensitive.

The other characters are variable. The beak is either short and thick, or long and cylindrical; the tarsi are dilated and spongy beneath, with the third joint broad and bilobed, or only hairy, with the third joint shorter and emarginate. The first and second ventral segments are long and connate; in the elongate species the other segments are moderately long; in the species with thick short beak they are shorter. The antennæ are inserted at a variable distance from the tip of the beak.

Sexual differences are not apparent in the short beaked species; in some of the elongate forms the beak is longer in the female.

Gradational characters are observed in the form of the beak, antennæ, tarsi and claws, varying by almost insensible degrees, so as to render the classification of this tribe very difficult. After several efforts, I am only able to offer the following table for the identification of the genera I have examined:

Beak flat, stout, more or less grooved, somewhat dilated at tip; prothorax angulated on the sides near the tip, then suddenly constricted. Antennæ rather stout, feebly geniculated; ventral segments 3–5 shorter than in the subsequent genera. Tarsi usually not spongy beneath, in which case the third joint is emarginate, not bilobed... **2.**

Beak cylindrical, rather stout, not dilated at tip; prothorax usually not angulated at the side; ventral segments 3–5 not so short; tarsi usually spongy beneath, claws connate at base.. **4.**

Beak cylindrical, varying in length, generally smoother than in the preceding genera; antennæ less approximate to the tip; prothorax not angulated at the sides: ventral segment 3–5 not very short; tarsi spongy beneath, third joint broad, bilobed; claws connate at base; second joint of funicle equal to first... **LIXUS.**

Digitized by Google

2. Prosternum without spines in front of the coxæ, 3.
Prosternum armed with short spines in front of the coxæ.............................. CENTROCLEONUS.
3. Beak strongly carinate, third joint of hind tarsi not spongy beneath..................... STEPHANOCLEONUS.
Beak feebly carinate, third joint of hind tarsi broad, spongy beneath................. CLEONOPSIS.
4. Hind tarsi with third joint shorter, emarginate, not spongy beneath................. CLEONASPIS.
Hind tarsi with third joint broader, bilobed, spongy beneath.. .... CLEONUS.

CENTROCLEONUS n. g.

Body oblong, more robust than usual in this tribe, above very coarsely sculptured. Beak stout, somewhat longer than the head, a little wider at tip, usually carinate, and broadly bisulcate above, tip not emarginate; antennal grooves suddenly deflexed, commencing not very near the tip. Mentum large, flat, gular peduncle very short and broad; neck finely transversely striate, with a deep median groove; eyes transverse, acute beneath, finely granulated. Antennæ geniculate, scape slender, equal to funiculus, which has six distinct joints, first and second nearly equal, third to sixth shorter, rounded, seventh forming part of the club. Prothorax wider than long, sides parallel, suddenly and strongly angulated near the tip, which is then strongly narrowed and constricted; postocular lobes broad, fringed; prosternum flattened, with an acute tubercle in front of each coxa; there are also two small prominences between the coxæ. Mesosternum shorter than first ventral; intercoxal process of abdomen broad rounded; 3–5 segments together scarcely longer than second. Legs moderate, terminal hooks of tibiæ small; tarsi hairy but not spongy beneath; hind tarsi with second joint a little shorter than first, third one-half shorter, deeply emarginate; claws approximate, not connate.

Conspicuous by the form of the prothorax, and very rough sculpture of upper surface. The species are rare, and may be distinguished as follows:

Elytra coarsely punctato-striate........... .... 2.
" more finely " " ; beak not carinate......... 4. **molitor.**
2. Pubescence intermixed with short hairs.............. ..... 3.
" " " long " ; alternate interspaces of elytra elevated........... .... 1. **pilosus.**
3. Beak strongly carinate.. 2. **angularis.**
" feebly " .... 3. **porosus.**

1. **C. pilosus,** n. sp.

Black, upper surface of beak, and above the eyes, sides of prothorax, and greater part of elytra densely clothed with gray hair, intermixed with long erect yellowish hairs; head and beak coarsely punctured, the latter with two broad grooves and an obtuse median carina; prothorax covered with large very deep foveæ, sub-carinate at the middle and depressed at base, sides broadly subsinuate; elytra with rows of very large punctures, alter-

Digitized by Google

nate interspaces elevated; two transverse denuded bands reach neither suture nor margin; beneath gray pubescent, with black dots. Length 11.5 mm.; .45 inch.

California: one specimen, given me by Mr. A. Murray.

2. **C. angularis.** *Cleonus ang.* Lec. Col. Kansas, p. 18, pl. 1, f. 12.

Kansas: specimens in my collection and in Dr. Horn's differ from the preceding by the hairs intermixed with the pubescence being short; the beak is more strongly carinate, the sides of the prothorax less sinuate, and the alternate interspaces of the elytra scarcely elevated.

3. **C. porosus,** n. sp.

Black, clothed with grayish and yellowish pubescence, with short hairs intermixed; beak coarsely punctured, with a feeble short carina at the middle, and two short shallow grooves; sides of prothorax nearly straight behind the postapical angle; elytra with rows of very large punctures, interspaces scarcely unequal; two indistinct darker transverse bands. Length 11.5 mm.; .45 inch.

One specimen, Cape San Lucas, Lower California, Mr. Xantus. The elytral striæ are composed of larger and less approximate punctures than in *C. angularis.*

4. **C. molitor.** *Cleonus molitor* Lec. Proc. Acad. 1858, 78.

California and Arizona. The pubescence is very dense, and scale like, not mixed with hairs, and is very easily abraded. The sculpture is much less coarse than in the other species, and the postapical angles of the prothorax are less prominent.

STEPHANOCLEONUS Motsch.

The essential characters of this genus consist in the prosternum without spines in front of the coxæ, the postapical angles of the prothorax obtuse or rounded, not at all prominent as in *Centrocleonus*; the antennæ are stout, feebly geniculate; first joint of funiculus longer, second only equal to the third, seventh forming part of the club. Beak rather stout, strongly carinate; tarsi hairy beneath, not spongy (except the third joint of the front and middle pairs); hind tarsi with first and second joints elongated, third shorter, emarginate, not bilobed, claws connate at base.

Humeri obliquely truncate.. 1. **plumbeus.**
Humeri rounded.. 2. **cristatus.**

1. **S. plumbeus,** n. sp.

Black, thinly clothed with nearly uniform whitish fine pubescence, producing a leaden lustre; beak stout, shorter than the prothorax, strongly carinate, carina extending upon the head, but not to the tip of the beak; broadly sulcate each side, separated from the head by a transverse concavity, confluently and finely punctured, lateral space in front of the eyes with a few very large punctures. Prothorax quadrate, suddenly narrowed near the tip, and transversely impressed at the sides, postocular lobes scarcely fringed, postapical angles rounded, sides nearly parallel, base broadly emarginate in two arcs of a circle, middle angle not rounded; disc

Digitized by Google

finely densely punctured with large scattered punctures, darker at the middle than at the sides, carinate in front of the middle but impressed behind. Elytra with humeri obliquely truncate, base not concave, sides subsinuate, obliquely prolonged behind, surface densely finely punctured, striæ composed of moderate sized punctures, with faint indications of two oblique bands, and a small denuded polished spot near the tips, which are separately rounded, or subacute. Length 9–11 mm.; .35–.45 inch.

North shore of Lake Superior; New Mexico. I have inadvertently mentioned this species in the list of Coleoptera of Lake Superior as *C. obliquus*, a European species which is quite different.

2. **S. cristatus**, n. sp.

Black, densely, finely punctured, clothed with white pubescence; beak strongly carinate, carina ending anteriorly in a fovea, prolonged backwards upon the head, broadly and deeply sulcate each side, lateral edges acute, well defined, upper surface sparsely, sides more densely coarsely punctured. Prothorax of the same form as in the preceding, but the postocular lobes have a short fringe of hair, the sides are nearly straight and parallel, the base is less emarginate, and the basal and medial angles are less prominent; the pubescence seems denser at the sides than on the disc; sculpture as in *S. plumbeus*. Elytra with striæ of smaller and more approximate punctures; humeri not obliquely truncate, but rounded and not prominent, sides feebly rounded, not subsinuate, less distinctly obliquely prolonged near the tips which are conjointly, not separately rounded; traces are seen of two dark oblique bands. Length 13 mm.; .50 inch.

One specimen, Utah, Dr. Horn. Easily known by the well defined lateral edge of the beak, and the different form of the elytra. The pubescence is less fine and more dense than in *S. plumbeus*.

CLEONOPSIS n. g.

I have been obliged to separate as a distinct genus, one species found in Texas and Colorado, which differs from *Cleonus* by stouter and flatter beak, the form and method of coloration, and by the joints of the funiculus of the antennæ, 2–6 being more closely united. It differs from *Stephanocleonus* by the hind tarsi broader, the third joint not shorter, deeply bilobed, with the lobes spongy beneath. I cannot identify it with any of the numerous genera mentioned by Mr. Chevrolat, though it would quite possibly enter into one of them.

1. **C. pulvereus.** *Cleonus pulv.* Lec. Col. Kansas and New Mexico, 18.

Three specimens. A rather stout species, proportioned somewhat like *C. trivittatus*, but with the prothorax suddenly tubulate in front, with a very broad discoidal black stripe, wider behind, and three oblique dark spots on each elytron. The beak is a little more than twice as long as wide, very coarsely punctured, feebly carinate, with slight traces each side of two grooves; the second joint of the funiculus is shorter than the first, but somewhat longer than the third. The basal margin of the elytra is much

Digitized by Google

thickened and elevated, the base just behind the margin is impressed. The scutellum is quite evident, and rather narrow. The base of the prothorax is obliquely emarginate each side, and the middle lobe longer than usual, with the angle rounded.

CLEONUS Sch.

Although the following species differ in minor details of structure, which by some entomologists are regarded as of generic value, there is such a general resemblance in appearance and in the more important characters, that it seems more natural to regard them as constituting one genus. I am the more confirmed in this belief from the impossibility of placing them with any satisfaction in the groups established on the species of the other continent, themselves very indefinite in extent.

I would therefore include under this head all the species in our fauna in which the beak is stouter than in *Lixus*, but not dilated at tip; the gular peduncle is not so broad and short as in the preceding genera, but is shorter than in *Lixus;* there is a difference between the species in this character, it being longer in proportion to the increasing slenderness of the beak. The front and middle tarsi are broad, the third joint at least spongy and bilobed; the hind tarsi are hairy beneath in the first division, but broad and spongy in the second. The general tendency of the pubescence is to form longitudinal stripes, and not transverse or oblique bands. The body is elongated, resembling *Lixus*.

Our species may be thus tabulated:

A. Hind tarsi with third joint incompletely spongy beneath, deeply emarginate, feebly bilobed. APLEURUS Chevr.

Prothorax gradually narrowed towards the tip...	2.
" suddenly narrowed towards the tip; sides sub-sinuate...	1. **collaris.**
2. Beak moderately strongly carinate; front not impressed...	3.
Beak less strongly carinate; front transversely impressed...	4.
3. Beak feebly carinate; front not impressed; elytra with broad black sutural and discoidal vittæ, speckled with white...	2. **trivittatus.**
Elytra uniformly clothed with yellowish pubescence...	3. **inornatus.**
4. Elytral vittæ irregular...	4. **frontalis.**
" " narrow, regular...	5. **virgatus.**
5. Elytra pubescent with the first, second, sixth and seventh interspaces darker...	6. **quadrilineatus.**

B. Hind tarsi with third joint spongy, broad, deeply bilobed.

Prothorax carinate before the middle...	3.
" not carinate before the middle...	2.

Digitized by Google

2. Pubescence short, pruinose....................		7. canescens.
" longer and coarser....,..		8. puberulus.
3. Prothorax sparsely coarsely punctured........		9. carinicollis.
" cribrate ; elytral punctures approximate		10. vittatus.
Prothorax sparsely cribrate; punctures distant		11. sparsus.

1. **C. collaris**, n. sp.

Black, thickly clothed with short dirt-colored pubescence ; beak not dilated at tip, sides suddenly deflexed, nearly flat above, with a very fine slightly elevated line, gradually becoming impressed in front, and not reaching the tip, ending behind in a small frontal fovea. Prothorax wider than long, sides irregularly rounded, bent obliquely inwards near the base, suddenly rounded and narrowed near the apex, which is bisinuate, and strongly impressed at the sides ; disc sparsely cribrate, obsoletely carinate before the middle, very deeply excavated behind, sides with a curved impression which makes the outline sinuate when viewed from above. Elytra each with a deep rounded sub-basal impression, and an oblique lateral one at about one-fourth of the length ; striæ composed of large somewhat distant punctures, which appear somewhat unequal in size, as they are more or less covered with the pubescence ; the first and marginal interspaces seem to be tesselated with darker. Beneath clothed with dirt-colored pubescence and speckled with black. Length 11 mm.; .45 inch.

One specimen from Colorado. Dr. Horn. The front and middle tarsi are spongy beneath, with the third joint broad and bilobed ; the hind tarsi are not spongy, the third joint is shorter than the second, but scarcely wider, and deeply emarginate rather than bilobed.

2. **C. trivittatus** Say, Curc. 10 ; ed. Lec. i, 270 ; Germ., Sch. Curc. ii, 222.

Colorado, rare.

3. **C. inornatus**, n. sp.

Black, head densely punctured with a few coarse punctures, beak coarsely punctured, the latter distinctly carinate, and marked with two vittæ of pale-brown hair ; prothorax longer than wide, gradually narrowed from the base forwards, feebly rounded on the sides, not constricted and but feebly impressed on the sides towards the tip ; base bisinuate, middle lobe broadly rounded ; disc densely punctured, sparsely and very coarsely punctured, broadly but not deeply foveate at base, distinctly carinate in front of the impression, with four stripes of pale-brown hair, the discoidal ones being sinuate, the outer ones lateral. Elytra without impression, humeri rounded, sides parallel, striæ composed in front of rather distant punctures, but becoming definitely impressed toward the tip ; densely clothed with rather coarse pale brown pubescence, which is a little thinner on the second and eighth interspaces. Beneath similarly pubescent, speckled with black. Length 13.5 mm.; .53 inch.

One specimen. Owen's Valley, California, Dr. Horn. The hind tarsi are

Digitized by Google

rather wider than in *C. collaris*, and the third joint is more distinctly bilobed, with a portion of each lobe spongy beneath. The same character is seen in *C. trivittatus*.

4. **C. frontalis**, n. sp.

Black, densely punctured, head sparsely, beak coarsely punctured, the latter uniformly pubescent with yellowish-gray hair, cylindrical, obsoletely carinate, broadly concave transversely at base; prothorax not longer than wide, gradually narrowed and feebly rounded from the base, which is bisinuate, with the middle lobe acute, tip not constricted, feebly impressed at the sides; disc with four broad stripes of pubescence, and with scattered very coarse punctures, not distinctly carinate, basal impressions oval, not very deep. Elytra with three broad basal impressions, humeri rounded, sides parallel, striæ composed of large distant punctures; densely clothed with moderately fine yellowish-gray pubescence, with a broad sutural and another discoidal stripe more thinly pubescent, speckled with denser spots. Beneath similarly pubescent, thickly speckled with black. Length 9 mm.; .36 inch.

Wyoming Territory, Dr. W. A. Hammond; Nevada, Dr. Horn. Smaller and more slender than *C. trivittatus*, and quite distinct by the above characters. The third joint of the hind tarsi is rather bilobed than emarginate, and is spongy at the tip of the lobes. The frontal concavity is broad and vague, and separates the head from the beak.

One specimen has the beak distinctly carinate, and the frontal impression much deeper, but does not otherwise differ.

5. **C. virgatus**, n. sp.

Black, densely punctured, head sparsely, beak coarsely punctured, thinly pubescent, sub-carinate, with a broad transverse frontal impression; prothorax a little longer than wide, 4-vittate with pubescence, gradually narrowed from the base, scarcely rounded on the sides, very coarsely cribrate, finely carinate, basal impression very feeble, base deeply bisinuate, middle lobe acute. Elytra without impressions, striæ composed of large equal not distant punctures, tolerably densely pubescent, with the second, sixth, and eighth interspaces thinly pubescent, and therefore darker. Beneath rather coarsely pubescent and speckled with black. Length 7 mm.; .28 inch.

One specimen, Owen's Valley, California, Dr. Horn. The third joint of the hind tarsi is bilobed, and spongy beneath, but is shorter than the second joint.

6. **C. quadrilineatus.** *Apleurus quadr.* Chevrolat, Mem. Acad. Liége, 2d ser. v. 80.

Texas. In this species the pubescence is fine, the beak stouter and shorter, feebly carinate, with a small frontal fovea, the upper surface densely pubescent, the sides black. The prothorax very coarsely and sparsely punctured, the interspaces finely punctulate; the disc is dark, with the sides and two narrow lines converging in front cinereous; base broadly impressed at the middle, oblique each side, not acute at the scutellum. Elytra rather finely punc-

Digitized by Google

tato-striate, with two cinereous vittæ occupying the third, fourth, and fifth, and three outer interspaces, apices separately rounded, and slightly acuminate. Hind tarsi with the third joint not broader than the second, bilobed, not spongy beneath. Length 8.75–11.8 mm.; .35–.46 inch.

7. **C. canescens**, n. sp.

Black, clothed with extremely fine and short, almost pruinose pubescence. Beak very stout, slightly thickened at tip, shorter than the prothorax, coarsely punctured, strongly carinate; carina abbreviated one-fourth from the tip, which is not emarginate, ending behind in a frontal puncture. Prothorax a little wider than long, sides nearly parallel, suddenly rounded and narrowed at the tip, which is feebly impressed at the sides, base broadly bisinuate, middle lobe feebly angulated, basal angles obtuse and rounded, disc densely punctulate, sparsely and very coarsely punctured, basal concavity deep, extending nearly to the middle. Elytra with rounded humeri, a little wider than the prothorax, sides parallel, then obliquely narrowed, tip obtusely rounded, semicircularly deeply impressed around the scutellum, which is small and deeply placed, front end of suture elevated, forming a small cusp; striæ composed of large distant punctures, interspaces flat, scarcely wider than the space between the individual punctures of the rows, slightly mottled with dots of denser whitish pubescence, and spots of a darker color. Beneath more coarsely and densely gray-pubescent, with large black punctures. Hind tarsi longer than the others, first joint longer than the second, third broader, bilobed, with the lobes spongy beneath, broadly grooved at the middle. Length 10 mm.; .40 inch.

Colorado. Four specimens given me by Mr. Ulke. The beak is thicker than in the neighboring species, and it is otherwise easily recognized.

8. **C. puberulus**, n. sp.

Black, clothed with coarse pale gray pubescence. Beak coarsely punctured, rather stout, not dilated at tip, sides parallel, upper surface not very convex, scarcely carinate, front feebly concave transversely. Prothorax not longer than wide at base, gradually narrowed in front, feebly constricted at the tip, base broadly bisinuate, middle lobe broadly rounded, disc with a few large scattered punctures, black, with the sides and two broad converging vittæ, which almost meet at the tip, gray; basal excavation very large and deep, extending beyond the middle. Elytra wider than the prothorax, broadly impressed around the scutellum, and flattened towards the humeri, which are rounded, sides parallel, then obliquely narrowed, tips obtusely rounded, sub-acuminate; striæ composed of large close set punctures, interspaces slightly convex, first, second, and seventh darker, and mottled with a few small spots. Beneath with large scattered black punctures; hind tarsi with first joint not longer than second, third joint slightly wider, bilobed, lobes spongy beneath. Length 8–9.5 mm.; .32–.375 inch.

Nevada; several specimens.

Digitized by Google

9. **C. carinicollis**, n. sp.

Black, pubescence short and dense, gray. Beak shorter than the prothorax, stout, a little thicker at the tip, coarsely punctured, not strongly carinate for more than half its length, carina terminating at each end in a puncture, with a broad groove each side extending from the tip about one-fourth the length. Prothorax longer than wide, narrowed in front, sides broadly rounded, base oblique, broadly angulated and rounded at the middle, densely punctulate, sparsely and irregularly coarsely punctured, basal excavation feeble, V-shaped, medial carina strong, extending from tip nearly to base. Elytra a little wider than the prothorax, broadly impressed around the scutellum and also near the humeri, which are oblique and less rounded than usual, sides straight, then obliquely narrowed, tip obtusely rounded, not acuminate; striæ composed of deep separate, but not very distant punctures, first and second, sixth, seventh, and eighth interspaces less mottled with pubescence than the others. Hind tarsi with the first joint longer and narrower than the second, third wider, broadly bilobed, all of them spongy beneath, with a narrow median groove. Length 13.5 mm.; .53 inch.

One specimen collected by me in Colorado. This species is of nearly the same form as *C. trivittatus*, but the elytra are more obliquely narrowed near the tip, and the other characters are very different. The hair seems to be abraded from the head and prothorax. The scutellum is narrow but more obvious in this than in the other species.

10. **C. vittatus** Kirby, Fauna Bor. Am. iv, 199.

Black, clothed with very fine short pruinose pubescence; beak stout, a little wider at tip, feebly carinate for more than half its length, with a broad frontal concavity, densely punctured above, sparsely and more coarsely at the sides. Prothorax longer than wide, sides nearly parallel, suddenly rounded and narrowed near the tip, base emarginate each side, middle lobe prominent, rounded, side angles acute; disc densely punctured and cribrate, basal excavation narrow, deep, medial carina distinct, extending from the tip to the excavation; sides and two dorsal vittæ which are broad at base and narrow in front, pubescent. Elytra with rows of deep, rather approximate punctures, interspaces flat, third and seventh less pubescent, and therefore darker; base flattened around the scutellum, and again near the humeri, which are rounded; sides parallel, then obliquely narrowed, tips obtusely rounded. Hind tarsi with the first joint a little longer, second and third spongy beneath, the latter broader and bilobed. Length 8 mm.; .32 inch.

One specimen from Oregon, and two from California.

11. **C. sparsus**, n. sp.

Black, pubescence less fine, yellowish-gray. Beak cylindrical, not very stout, not wider at tip, punctured, scarcely carinate, with a broad frontal impression. Prothorax a little longer than wide, very slightly narrowed in front except near the tip, where it is suddenly rounded and narrowed and

Digitized by Google

slightly tubulate, base strongly emarginate each side, middle lobe rounded, side angles acute; disc punctulate with a few very large scattered punctures; medial carina distinct, basal excavation narrow, deep; sides and broad dorsal vittæ becoming narrower in front, pubescent. Elytra as in the preceding; except that the striæ are composed of distant punctures; the second and sixth interspaces are less pubescent and darker. Hind tarsi as in *C. vittatus.* Length 6.5 mm.; .25 inch.

One specimen from Colorado, in the collection of Dr. Horn.

CLEONASPIS n. g.

C. lutulentus differs from *Cleonus* by the hind tarsi being narrow, with the first joint longer than the second, and the third evidently shorter, not wider, and emarginate, not bilobed, and not spongy beneath. The beak is cylindrical, rather stout, a little shorter than the prothorax, and not at all carinate. The prothorax is a little longer than wide, slightly and gradually narrowed in front, feebly constricted at the apex; the base is oblique and very feebly emarginate each side, with the middle lobe obtuse, scarcely prominent; the side angles are acute; the disc sparsely, coarsely punctured, obsoletely carinate, and the basal excavation is hardly perceptible. The elytra are transversely impressed at base, the humeri are not rounded, the sides are straight, and then almost regularly rounded to the tip; uniformly pubescent; the striæ are composed of large, rather approximate punctures. The scutellum is not depressed, triangular, longer than wide. The antennæ are more slender than in *Cleonus*, with the first joint of the funiculus longer than the second, which is equal to the third; joints 2–6 rather closely connected. The antennal grooves are not confluent below, or I should place this species in *Mecaspis.*

1. **C. lutulentus.** *Cleonus lut.* Lec. Col. Kans. 18.

Two specimens, New Mexico. The pubescence is of a uniform dirty brown, except that there is a slightly darker broad dorsal prothoracic stripe, becoming broader towards the base.

LIXUS Fabr.

The species of this genus are generally more slender than those of *Cleonus*, though not always. The tarsi are broad and spongy beneath, with the third joint deeply bilobed. The beak is cylindrical, not thickened at tip, usually slender, except in *L. pleuralis* and *texanus*, and not carinated, except in *L. pleuralis* and *sylvius*. The antennal grooves commence at some distance from the tip of the beak. The antennæ, except in *L. pleuralis* and *texanus* are slender, with the first joint of the funiculus thicker, and the second as long as the two following united; in those two the funiculus is less elongated, less slender, and the second joint is somewhat less elongated.

The species are numerous and difficult to distinguish; they are covered with a pollinose yellowish powder which is easily rubbed off, and in addition, some of them are pubescent. In several species the apices of the

Digitized by Google

elytra are prolonged into an acute spine, and the beak of the ♂ is frequently shorter and stouter than in the ♀.

A. Beak rather stout, subcarinate	2.
B. " " " not carinate	3.
C. " more slender, not carinate, except in *sylvius*	4.
2. Basal excavation of prothorax deep; surface above thinly clothed with gray pubescence; sides of prothorax, elytra and under surface densely white pubescent	**1. pleuralis.**
3. Basal excavation of prothorax broad, not deep, surface dull, finely pubescent	**2. texanus.**
4. Antennæ moderately slender, first joint of funicle stouter than second	5.
Antennæ longer, more slender, first and second joints of funicle equal, each as long as the four following united	17.
5. Tips of elytra prolonged, pubescence pruinose	6.
" " not prolonged	9.
6. Body very elongated	7.
" less elongated; pubescence less fine, gray	8.
7. Pubescence gray, very fine	**3. rubellus.**
" yellowish, denser	**4. auctus.**
8. Tips of elytra long	**5. caudifer.**
" " very short; prothorax asperate	**6. asper.**
9. Beak strongly, though not coarsely punctured	10.
" finely, densely punctulate	12.
" sparsely punctulate or nearly smooth; antennæ inserted about the middle of the length; basal concavity of prothorax feeble	15.
10. Beak obsoletely carinate	11.
" distinctly "	**7. sylvius.**
11. Prothorax with shallower punctures	**8. punctinasus.**
" " few deep " (smaller)	**9. parcus.**
12. Antennæ inserted ⅓–¼ from the tip	13.
" " near the tip, prothorax not rounded on the sides	**10. terminalis.**
13. Prothorax shorter, rounded and sub-sinuate on the sides	14.
Prothorax long, not rounded on the sides	**11. rectus.**
14. Body long, elytral impressions not deep	**12. mucidus.**
" " " " deep	**13. concavus.**
" shorter and stouter than usual	**14. musculus.**
15. Elytra conjointly rounded at tip	16.
" sub-acuminate at tip	**15. perforatus.**
16. Prothorax with sides rounded in front	**16. scrobicollis.**

Digitized by Google

Prothorax with sides feebly rounded in front; disc channeled for two-thirds the length...... 17. **placidus.**
Prothorax more strongly cribrate.............. 18. **laesicollis.**

17. Antennæ inserted at the middle of the beak in ♀; about one-third from tip in ♂; large, slender, rather shining, thinly and finely pubescent...... 19. **macer.**

1. L. **pleuralis** Lec., Pr. Ac. Nat. Sc. Phila. 1858, 78.

Arizona and Lower California.

The specimens from Cape San Lucas are more pubescent, and in some individuals the pubescence is a little mottled on the elytra. It is perhaps *L. modestus* Mann. Bull. Mosc. 1843, 291; *L. californicus* Motsch. Bull. Mosc. 1845, 378.

2. L. **texanus,** n. sp.

Black, thinly clothed with gray or yellowish-gray hair, denser towards the sides, head and beak sparsely coarsely punctured, the latter stout, shorter than the prothorax, feebly carinate for half the length; antennæ inserted near the tip, not slender, first and second joints of funiculus equal, each as long as the two following. Prothorax scarcely longer than wide, gradually narrowed in front, broadly rounded on the sides, not constricted at tip, covered with large, not very deep punctures, basal excavation feeble. Elytra wider behind the base than the prothorax, humeri rounded, sides parallel, conjointly rounded at tip, striæ composed of large not very distant punctures. Thighs slender, tarsi with the last joint as long as the others united. Length 8–10.3 mm.; .32–.40 inch.

Two specimens from Texas; Mr. A. Sallé.

3. L. **rubellus** Randall, Bost. Journ. Nat. Hist. ii, 41.

Brownish-black, thinly clothed with very short, fine gray pubescence; long, slender. Beak somewhat shorter than the prothorax, densely, finely punctured, with a few larger punctures intermixed; obsoletely carinate, with a large frontal puncture. Antennæ inserted near the tip of the beak. Prothorax longer than wide, gradually narrowed from base to tip, not constricted, sides nearly straight, base slightly oblique each side, medial angle very obtuse, not rounded; surface rugosely punctulate, with a few shallow punctures intermixed, excavation shallow, extending from base nearly to the tip. Elytra finely rugosely punctulate, with striæ composed of not very distant punctures, tips prolonged, divergent, not acute. Legs brown, thighs slender. Length 8 mm.; .32 inch.

One specimen, Wisconsin. Mr. Randall's specimen measured .45 inch from tip of beak, and was found in Massachusetts.

4. L. **auctus** Lec., Pac. R. R. Expl. and Surv. Insects, p. 57.

One ♀ specimen, Oregon. Larger than the preceding, with the beak more slender, and the antennæ inserted about one-fourth from the tip, (probably sexual characters); there is a well-marked frontal puncture, and

Digitized by Google

another between the insertions of the antennæ. The form and sculpture are similar in the two species, but the pubescence is much more dense in this one.

5. L. **caudifer**, n. sp.

Rather stout, black, densely clothed with fine short gray pubescence. Beak slender, not as long as the prothorax, nearly smooth, finely pubescent at base, naked at the tip. Antennæ inserted about one-fourth from the tip; frontal fovea elongate. Prothorax a little wider than long at the base, gradually much narrowed in front and not constricted, sides slightly rounded, base feebly emarginate each side, middle angle prominent, acute; dorsal excavation large, triangular, channeled, surface densely punctulate, with scattered shallow punctures. Elytra a little wider behind the base; medial impression broad, not deep; striæ composed of rather large distant punctures, tips prolonged, not divergent, but parallel. Thighs slender. Length 9.7–14 mm.; .38–.55 inch.

♂. Beak less slender, uniformly pubescent, a little broader at tip, and slightly flattened.

♀. Beak a little narrower, smooth, and naked at tip.

Three specimens, Illinois; found also in British Columbia.

6. L. **asper**, n. sp.

Rather stout, black, without lustre, clothed with fine gray pubescence. Beak as long as the prothorax, slender, densely punctured, more finely towards the tip; antennæ inserted about one-third from the tip, frontal fovea distinct. Prothorax scarcely wider at base than long, gradually much narrowed in front, feebly constricted, sides slightly rounded, base feebly emarginate each side, middle angle broad and rounded; surface densely punctulate, with scattered large partly elevated punctures, dorsal excavation large, triangular, rather deep, impressed at the middle of the base. Elytra wider than the prothorax, impressions wide and tolerably deep, striæ composed of approximate punctures, tips separately acuminate, though scarcely prolonged. Legs as in the preceding species. Length 11.3 mm.; .45 inch.

Three ♀, and one ♂; Owen's Valley, Cal., Dr. Horn. Quite distinct by the rough, partly elevated punctuation of the prothorax. The beak in the ♂ is less slender, and the antennæ are one-fourth from the tip; in the ♀ the apical part is longer, so that they are inserted at one-third the length from the tip; it also appears very obsoletely carinate in the latter sex from the front to near the insertion of the antennæ.

7. L. **sylvius** Boh., Sch. Curc. vii, 430.

One ♂ Pennsylvania; coll. Horn. I refer to this species a single specimen, in which the body is black, shining, thinly clothed with fine cinereous pubescence, the beak rather stout, as long as the prothorax, strongly punctured. feebly but distinctly carinate from the frontal puncture to the insertion of the antennæ; the prothorax punctulate and coarsely punctured, with a small deep impression at the base; not longer than wide, nar-

Digitized by Google

rowed in front, feebly rounded on the sides, medial basal angle obtuse, not rounded. Elytra a little wider than the prothorax, transversely impressed behind the base, striæ composed of distant punctures, interspaces scarcely punctulate, tips separated, rounded, sub-acuminate. Length 8.5 mm.; .35 inch.

8. **L. punctinasus**, n. sp.

Black, thinly clothed with fine gray pubescence. Beak rather stout, as long as the prothorax, with the head strongly but not coarsely punctured, with scarcely a trace of carina, frontal fovea distinct; antennæ inserted near the tip of the beak. Prothorax not longer than wide, gradually strongly narrowed in front, moderately rounded on the sides, base emarginate each side, medial angle obtuse not rounded, disc rugosely punctulate with many large shallow punctures, basal impression small, deep. Elytra a little wider than the prothorax, separately rounded at tip, basal impressions not deep, striæ composed of distant punctures. Legs as in the preceding species. Length 7.7 mm.; .30 inch.

One ♂ Ohio. Not very different from the preceding species, but to be regarded as distinct on account of the antennæ being nearer the tip of the beak, which is not carinate, and the tips of the elytra being separately rounded and not sub-acuminate.

9. **L. parcus**, n. sp.

Black, thinly clothed with coarser gray pubescence. Beak rather stout, not carinate, as long as the prothorax, strongly punctured, front transversely impressed, with a well-marked fovea. Antennæ inserted very near the tip of the beak. Prothorax wider than long, much narrowed in front, moderately rounded on the sides, base obliquely emarginate each side, medial angle obtuse, prominent, not rounded; surface punctulate, sparsely coarsely punctured, basal impression vague, deep at the middle of the base. Elytra wider than the prothorax, tips rounded, basal impressions moderately deep, striæ composed of large distant punctures. Legs as in the preceding species. Length 5.5 mm.; .22 inch.

One ♂ California, Dr. Horn. The smallest species I have seen, and easily known by the coarsely punctured beak.

10. **L. terminalis**, n. sp.

Elongate, black, cinereous pubescent, mottled with small spots of denser hair; beak not very slender, as long as the prothorax; finely and densely punctulate, sides coarsely punctured; antennæ inserted near the tip. Prothorax longer than wide, gradually narrowed from the base, sides straight, base broadly emarginate each side, medial angle small, pointed; surface finely punctured, with other somewhat larger punctures, dorsal impression extending nearly to the tip, channeled, deeper at the base. Elytra not wider than the prothorax, basal impressions not large, moderately deep, striæ composed of distant punctures, tips separately rounded. Thighs moderately clavate. Length 9–11 mm.; .35–.45 inch.

♂. More densely pubescent, not shining.

♀. Less pubescent, shining.

Digitized by Google

Middle and Western States, not rare. Easily known by the separately rounded elytral tips. There is no sexual difference in the position of the antennæ, but the beak is a little longer in ♀ than in ♂. The antennæ are inserted about one-fifth the length from the tip.

One ♂ from Georgia differs in having the punctures of the elytra less distant, and the tips of the elytra more broadly rounded. It is perhaps a distinct species.

11. L. **rectus**, n. sp.

Elongate, finely pubescent, frequently pollinose, beak longer than the prothorax, upper surface finely and densely punctured, punctulate beyond the middle, antennæ inserted about one-third from the tip. Prothorax longer than wide, narrowed from the base, sides nearly straight, base emarginate each side, medial angle prominent, obtuse, not rounded; surface with approximate shallow punctures, interspaces finely punctured, dorsal concavity long, triangular, deep towards the base. Elytra not wider than the prothorax, striæ composed of rather distant punctures, basal impressions deep, tips separately rounded. Length 10.5 mm.; .42 inch.

One ♀, New York. Allied to *L. concavus*, but narrower, with the prothorax longer, and not rounded on the sides. I associate with this species one ♂ from Georgia, in which the beak is more pubescent, the antennæ less distant from the tip (about a quarter of the length), and the tips of the elytra conjointly rounded. It may indicate a distinct species, but I am unwilling to separate it at present.

12. L. **mucidus**, n. sp.

Large, rather robust, black, densely clothed with fine gray pubescence; beak longer than prothorax, upper surface densely finely punctulate, obsoletely carinate behind the antennæ, which are inserted about one-quarter from the tip. Prothorax wider than long, rounded on the sides, scarcely constricted at tip, densely finely punctured, and with scattered, larger, tolerably deep punctures, base emarginate each side, medial angle prominent, not rounded; dorsal excavation oval, deep. Elytra a little wider than the prothorax, basal impressions wide not deep, striæ composed of moderately distant punctures, tip conjointly rounded. Length 14.5 mm.; .57 inch.

One pair, Illinois, in the ♂ the beak is more densely pubescent, and the antennæ are somewhat nearer the tip.

13. L. **concavus** Say, Curc. 14; ed. Lec. i, 275; Boh., Sch. Curc. iii, 57.

Atlantic district, not rare. The beak is finely punctulate on the upper surface, the antennæ are inserted in ♂ about one-fourth, in ♀ about one-third from the tip; the punctures are denser in the former. The prothorax is wider than long, rounded on the sides, distinctly constricted at tip. The dorsal excavation is large, triangular and deep. The basal impressions of the elytra are also deep, and the tips are conjointly rounded.

14. L. **musculus** Say, Curc. 14; ed. Lec. i, 276; *L. calandroides* Randall, Bost. Journ. Nat. Hist. ii, 42.

Digitized by Google

Canada to Texas; Colorado. Shorter and stouter than our other species, and variable in appearance, according as the pubescence is well preserved or abraded. There is also some variation in the number and depth of the large punctures of the prothorax. The antennæ in ♂ are about one-fourth from the tip of the beak; in ♀ about one-third. The prothorax is wider than long, strongly narrowed in front, rounded on the sides, feebly constricted at tip; the dorsal excavation is not deep except at the base.

15. L. **perforatus**, n. sp.

Elongate, black, thinly clothed with gray pubescence. Beak as long as the prothorax, finely punctured; head very coarsely punctured. Prothorax longer than wide, narrowed in front, feebly rounded on the sides, which are more thickly pubescent, very deeply and coarsely punctured, interspaces densely punctulate, basal excavation small. Elytra a little wider than the prothorax, scutellar impression wide not deep, intrahumeral impressions deep; striæ composed of subquadrate not distant punctures, tips separately acuminate, but not prolonged; the inner and outer interspaces more densely pubescent, but not very obviously so.

♂. Beak stouter, densely punctured, more coarsely on the sides, more finely towards the tip; antennæ one-third from the tip.

♀. Beak more slender, shining, sparsely and finely punctured, sides sparsely and less finely punctured. Antennæ inserted about the middle of the beak.

California, Fort Tejon. The elytral striæ are alternately a little nearer.

16. L. **scrobicollis** Boh., Sch. Curc. iii, 84; *L. lateralis*‖ Say, Curc. 14; ed. Lec. i, 276.

One ♀ specimen, Kentucky. A small species easily known by the sides of the prothorax nearly parallel, much rounded and constricted near the tip; the dorsal excavation is small and basal; the punctures very large and deep, though sparse. The sides of the prothorax and elytra are more densely pubescent; the tips of the elytra are rounded; the antennæ are inserted at the middle of the beak, which is sparsely punctulate, with a few punctures intermixed at the base and sides. Length 7 mm; .27 inch

17. L. **placidus**, n. sp.

Black, somewhat shining, thinly pubescent, sides of prothorax and sub marginal broad vitta of elytra whitish pubescent. Beak rather stout, as long as the prothorax, finely not densely punctured, with a few larger punctures towards the base and on the sides; antennæ inserted at the middle of the beak. Prothorax a little longer than wide, gradually narrowed from the base, feebly rounded on the sides, not constricted at tip, finely punctured, with scattered not remote, moderately large but not very deep punctures, disc channelled, with a small basal impression. Elytra a little wider than the prothorax, conjointly rounded at tip, basal impressions shallow; striæ composed of large rather distant punctures. Length 10 mm.; .40 inch.

Two ♀, Colorado. A very distinct species of moderately elongate form.

Digitized by Google

18. **L. læsicollis** Lec., Proc. Ac. Nat. Sc. Phila., 1858, 78.

Texas. Beak stout, finely punctured, base, sides and head coarsely punctured; prothorax very coarsely and tolerably densely cribrate, sides nearly parallel, rounded near the tip, basal impression small. Elytra with deep basal impressions; striæ composed of distant large punctures, tips conjointly subacute, scarcely rounded.

19. **L. macer**, n. sp.

Very elongate, black shining, thinly clothed with fine gray pubescence. Beak longer than prothorax, curved, not stout, punctured; head sparsely punctured. Prothorax scarcely longer than wide, strongly narrowed in front, feebly rounded on the sides, punctulate, with larger not deep punctures, middle of base deeply impressed, base emarginate each side, middle angle prominent, obtuse, rounded at tip. Elytra a little broader than the prothorax, basal impressions deep, striæ composed of rather approximate punctures; tips conjointly subacute, slightly rounded. Length 12–19.5 mm.; .48–.77 inch.

♂. Beak stouter, a little longer than the prothorax, antennæ inserted one-third from the tip.

♀. Beak nearly twice as long as the the prothorax, antennæ inserted about the middle.

Southern and Western States to Colorado and Texas; not rare. I cannot understand how this species has remained undescribed. It is easily known not only by the large size and elongate form, but by the slender antennæ; the first and second joints of the funiculus are equal, and very long. In some specimens there is a broad, sub-marginal pubescent vitta on the elytra, and in one individual this extends upon the sides of the prothorax.

SPECIES NOT IDENTIFIED.

L. marginatus Say, Curc. 13; ed. Lec. i, 275; Boh., Sch. Curc. iii, 70.

L. præpotens Boh., Sch. Curc. iii, 62; *Rhynchophorus præpotens* Say, Curc. 21; ed. Lec. i, 287.

L. poricollis Mann., Bull. Mosc. 1843, ii, 291.

L. modestus Mann., Bull. Mosc. ibid; *L. californicus* Motsch., ibid. 1843, ii, 378. Perhaps *L. pleuralis* Lec. (p. 155).

Tribe V. ERIRHININI.

This tribe consists of a great number of species, all of small size, and representing a large number of genera. Most of them are found near water, on plants, and some of them are quite aquatic in their habits. In the beak, prosternum, tibiæ and tarsi they differ greatly, so as to permit the recognition of several groups, as will be seen below, but they agree in the following characters:

Mandibles with three teeth, separated by two emarginations, the middle tooth more prominent; in the group *Desmorhines* the outer side of the mandibles, by the transposition of the inferior tooth, becomes toothed as

Digitized by Google

in *Rhynchitidæ*; gular peduncle longer than wide, slightly emarginate, mentum small, not transverse, ligula and palpi prominent, smaller than in *Hylobiini*. The beak is cylindrical, sometimes very long and slender, sometimes rather stout; the antennal grooves commence at a distance from the tip, descend obliquely, and sometimes become confluent behind. The antennæ are geniculate, the scape long and slender; funiculus usually 7-jointed, sometimes (*Endalus*) 6-jointed; club oval, annulated, entirely clothed with sensitive surface except in *Lissorhoptus*. Prothorax with or without postocular lobes; front coxæ contiguous, prosternum flat, emarginate, or not, in front, sometimes (*Bagous*) broadly sulcate for reception of the beak. Mesosternum with the side pieces diagonally divided, epimera not attaining widely the base of the prothorax. Metasternum usually long, rarely (*Phycocœtes*) very short; side pieces narrow, dilated in front. Hind coxæ widely separated, transverse, narrower externally, and extending almost to the elytral margin. Legs never very stout, thighs usually simple, rarely (*Dorytomus*) toothed; tibiæ truncate at tip and feebly mucronate in most genera, strongly unguiculate in *Bagoi*. Tarsi usually dilated, narrow in certain genera; last joint sometimes long, sometimes short; claws not toothed, divergent, sometimes connate (*Desmorhines*), or single (*Brachybamus*); last joint wanting in the European genus *Anoplus*.

Ventral segments unequal, third and fourth united about equal to the second or fifth; sutures straight, excepting the first which is sinuate in most genera, and the last, which is broadly curved in *Stenopelmus*.

Our genera are numerous, and indicate several groups; in fact, all of those recognized by Lacordaire are represented, and I have found it necessary to establish two others.

The affinities of the tribe are in several directions: towards the *Hylobiini*, *Emphyastini* (*Phycocœtes*), *Ceutorhynchini* (*Hydronomi*).

Mesosternum as long as first ventral segment,	2.
" very short.....................	viii. PHYCOCŒTES.
2. Tibiæ truncate at tip, feebly mucronate....	3.
" not truncate, strongly unguiculate..	vii. HYDRONOMI.
3. Eyes contiguous to prothorax.............	4.
" distant from "	iii. EUGNOMI.
4. Body scaly or pubescent..................	5.
" covered with a waterproof crust.....	6.
5. Beak not constricted at base; claws divergent................................	i. ERIRHINI.
Beak strongly constricted at base: claws connate or approximate.................	ii. DESMORHINES.
6. Tarsi with third joint bilobed............	7.
" " " " simple; beak short and stout..............................	iv. STENOPELMI.
7. Last joint of tarsi short..................	v. CRYPTOPLI.
" " " " long..................	vi. BRACHYPI.

Digitized by Google

Group I. Erirhini.

The species have the beak long, usually slender, the mandibles with two sharp teeth at the end; the inferior cusp in *Erycus* comes to the outer margin, and is not very prominent, but thus shows a tendency to assume the position which it has in the next group. The antennal grooves are directed against the eyes, and do not converge beneath. The scape nearly or quite attains the eyes, and the first, and usually the second joint of the funicle are longer than the others. The mesosternum is as long as the first ventral; the legs are slender, tibiæ truncate at tip, and feebly mucronate; the tarsi are spongy beneath, with the third joint dilated and bilobed; last joint long, claws rather strong, simple, divergent.

This group recedes in the direction of the *Phytonomini* and *Hylobiini*.*

Thighs not toothed, prosternum emarginate..........	2.
" toothed, prosternum not "	DORYTOMUS.
2. Body pubescent or glabrous......................	3.
" densely clothed with scales.................	GRYPIDIUS.
3. Antennæ inserted far from the tip of the beak.....	ERYCUS.
" " near " " "	PROCAS.

PROCAS Stephens.

This genus bears a strong resemblance to *Erycus*, but differs in having the beak rather less slender, and the antennæ inserted very near the tip; the second joint of the funicle is shorter than the first, though longer than the third. The prosternum is strongly emarginate in front, and the post-ocular lobes are broad. The thighs are unarmed, the tibiæ straight, strongly pubescent, truncate at tip, and scarcely mucronate; the hind pair have two small terminal spines or spurs, as mentioned by Tournier.†

1. **P. picipes** Stephens, Ill. British Ent. iv, 90; Boh., Sch. Curc. vi, 387. *Erirhinus Steveni* Gyll., Sch. Curc. iii, 287: *Procas Steveni* Sch. Curc. vi, 387.

Lake Superior; Ulke. My specimen agrees so closely with the description and figure (DuVal, Gen. Col. Eur. iv. pl. 13, f. 58), that I do not venture to separate it. Opaque, black, slightly mottled with spots of very fine pubescence; head and beak very densely punctured. Prothorax a little wider than long, rather small, rounded on the sides, narrower in front, and very slightly constricted; very densely punctured. Elytra one-third wider than the prothorax, oblong, humeri rounded, striæ deep, catenate with distant punctures; interspaces wide, flat, finely and densely rugose and subgranulate. Beneath densely punctured, less opaque. Length, 5.3 mm; .21 inch.

* The following species do not belong to this tribe: *Erirhinus ephippiatus* Say, has the thighs not toothed, and the claws broadly appendiculate; it indicates a new genus *Alyca* of *Anthonomini*. *Erirhinus juniperinus* Sanborn, is an *Anthonomus*. *Erirhinus lutulentus* and *rutilus* Boh., Sch. Curc. vii, 2d, 165 and 167 not identified.

† Annales Soc. Entom. Belgique, xvii.

Digitized by Google

GRYPIDIUS Sch.

1. **G. equiseti** Gyll., Sch. Curc. iii, 314; *Curculio eq.* Fabr., Ent. Syst. i, 403; *Rhynchænus eq.* Fabr., Syst. El. ii, 443, &c. &c.

A common European species which is is indigenous in Canada, Kansas, and on the north shore of Lake Superior. A Canadian specimen was sent me by Mr. W. Couper, which I determined simply as *Grypidius*, n. sp.?, but by some confusion of labels, in describing the species to which I had given no definite names, he has given the name *G. vittatus** to a small species of *Sitones*, apparently the *S. tibialis* of Europe, which occurs in Canada and in Hudson Bay Territory, perhaps imported, perhaps indigenous.

2. **G. brunnirostris** Gyll., Sch. Curc. iii, 316; *Rhynchænus br.* Fabr., Syst. El. ii, 445, &c.

Two specimens from Oregon do not appear sufficiently distinct from this European species. It is smaller than the preceding, and easily known by the elytral interspaces being even, not tuberculate, and the scales uniform in color.

ERYCUS Tournier, Ann. Ent. Belg. xvii.

This genus contains those species of *Erirhinus* in which the prosternum is deeply emarginate in front, and the postocular lobes broad and distinct. The hind tibiæ are feebly mucronate, and have in addition two very small spines or spurs.

But two species are known to me, the first of which differs but slightly from the European *E. æthiops*.

Nearly glabrous, shining; prothorax sparsely punctured.. 1. **morio.**
Mottled with pubescence; prothorax coarsely, densely punctured.. 2. **puncticollis.**

1. **E. morio** Mann., Bull. Mosc. 1853, ii, 240 (*Erirhinus.*)

Alaska, Vancouver Island, Great Slave Lake, Canada.

2. **E. puncticollis** n. sp.

Black, mottled with yellowish pubescence. Head and beak strongly not densely punctured; prothorax as long as wide, sides feebly rounded, more strongly in front, tip slightly impressed on the sides, surface coarsely and densely punctured. Elytra wider than prothorax, humeri rounded, striæ with quadrate approximate punctures, interspaces densely punctured, irregularly pubescent, with a more conspicuous sutural transverse spot behind the middle. Thighs somewhat clavate, not toothed; front and middle tibiæ moderately strongly mucronate, hind pair with a very small mucro, and small terminal spurs. Body beneath coarsely and densely punctured. Length 5.5–6 mm; .22–.25 inch.

Middle and Western States and Lake Superior. Looks like a small *Pissodes*.

* Canadian Naturalist 1865, p. 63; *v. ante*, p. 115.

Digitized by Google

DORYTOMUS Sch.

In this genus the prosternum is not emarginate in front, and the thighs are armed beneath with a distinct tooth; in the first three species this tooth is small and acute, in the others broader and nearly rectangular. The prothorax is narrower than the elytra, suddenly narrowed, and sometimes constricted in front, without postocular lobes. The body is mottled with spots of pubescence, which in *D. squamosus* is very short and scale-like. The species occur mostly on willows.

Thighs more slender, tooth small, acute; beak very long, striate; antennæ more slender, second joint of funicle longer than third..........	2.
Thighs stouter, tooth broader and larger..........	3.
2. Prothorax finely punctured, not constricted at tip....................................	**1. mucidus.**
Prothorax strongly punctured, suddenly constricted at tip...........................	**2. laticollis.**
Prothorax densely punctured, gradually rounded and feebly constricted at tip..............	**3. rufulus.**
3. Beak striate...............................	4.
" punctured, scarcely striate...............	7.
4. Prothorax not wider than long................	5.
" distinctly transverse, coarsely and densely punctured, suddenly narrowed at tip and constricted.......................	**4. brevicollis.**
5. Prothorax not constricted at tip..............	6.
" constricted " "	**5. luridus.**
6. " suddenly narrowed in front........	**6. subsignatus.**
" gradually rounded near the tip......	**7. longulus.**
7. Pubescence squamiform, slightly mottled, prothorax gradually rounded near the tip, not constricted..............................	**8. squamosus.**
Pubescence coarse, hairy, nearly uniform......	8.
8. Fulvous, with yellow pubescence..............	**9. Mannerheimii.**
Piceous with gray pubescence.................	9.
9. Pubescence of elytra mixed with longer hairs..	**10. hirtus.**
" " " " erect stiff hairs	**11. hispidus.**

1. D. **mucidus.** *Erirhinus muc.* Say, Curc. 14; ed. Lec. i, 277; Gyll., Sch. Curc. iii, 291.

Canada and Kansas, abundant at Los Angeles and Oakgrove, Cal.; G. R. Crotch. Larger than our other species, and easily recognized by the more finely punctured prothorax, and very long beak. Breeds in blossoms of cottonwood; develops very rapidly, (Riley).

2. D. **laticollis** n. sp.

Pitchy black, irregularly mottled with cinereous pubescence. Beak very long, slender, striate and coarsely punctured, strongly curved. Prothorax wider than long, rather coarsely punctured, without dorsal line, sides

Digitized by Google

rounded, suddenly narrowed near the tip, and strongly constricted. Elytra very little wider than the prothorax; striæ composed of close-set punctures, disc convex, obliquely impressed near the base, interspaces flat, finely punctulate. Thighs rather slender, armed with a small acute tooth. Length 4.5 mm; .175 inch.

Lake Superior and Iowa.

3. D. **rufulus**. *Erirhinus ruf.* Mann., Bull. Mosc. 1853, ii, 240.

Alaska: one specimen kindly sent by Baron Chaudoir. Smaller than the preceding, and very closely allied to it, differing chiefly by the sides of the prothorax less rounded, less suddenly narrowed and less deeply constricted at tip, and by the elytra one-third wider than the prothorax. The color is ferruginous, though this may not be of specific value. The beak is scarcely as long and slender, but the legs are similar. Mannerheim erroneously states that the thighs are unarmed.

4. D. **brevicollis**, n. sp.

Pitchy black, irregularly mottled with cinereous hair, antennæ and legs brown. Beak as long as the head and prothorax, strongly striate and coarsely punctured. Prothorax one-half wider than long, densely punctured, sides rounded, tip constricted; elytra one-third wider than the prothorax, convex; striæ closely punctured, interspaces sparsely punctulate. Thighs stout, with a rather large tooth. Length 3.5–4.3 mm; .14–.17 inch.

Western and Middle States and Lake Superior. Differs from the following species chiefly by the more transverse prothorax.

5. D. **luridus**. *Erirhinus lur.* Mann., Bull, Mos. 1853, ii, 241.

Alaska and California. I have a specimen in bad condition, from Georgia, which may possibly belong to this species, if not, it will indicate a new one closely allied. In well preserved specimens the pubescence is very coarse and mottled in color. The posterior callus of the elytra is somewhat distinct, but by no means sufficiently so to warrant Mannerheim's expression, "*elytris ante apicem utrinque tuberculo instructis.*"

Two smaller specimens from Alaska have the thorax less rounded on the sides near the tip, and in one of them there is a distinct smooth, narrow, dorsal vitta; they were sent to me as *Erirhinus vestitus* Mann., a very different species, which has the beak punctured but not striate.

Four specimens of small size were collected by Mr. Crotch in the Mojave Desert, Cal., which I would temporarily refer to this species. They are yellow brown with a broad darker stripe on each elytron They agree in form with the Eastern specimen, and are a little more robust than those from Alaska. Length 2.5 mm; .10 inch.

A larger series of well-preserved specimens will perhaps show the propriety of receiving these three forms as distinct species.

6. D. **subsignatus**. *Erirhinus subs.* Mann., Bull. Mosc. 1853, ii, 241.

Alaska, Count Mnizech and Prof. Mäklin.

Digitized by Google

7. **D. longulus**, n. sp.

Ferruginous (immature?), mottled with cinereous pubescence. Beak as long as the head and prothorax, nearly straight, not very slender, deeply striate and punctured. Prothorax not wider than long, gradually narrowed and rounded on the sides in front, and not constricted; densely though not coarsely punctured, with a slight trace of a smooth dorsal line. Elytra elongate, one-quarter wider than the thorax, convex, transversely impressed near the base, striæ closely punctured, margin impressed just behind the humerus. Thighs stout, with a broad tooth. Length 3.5 mm; .14 inch.

One specimen from Alaska sent with *D. rufulus*, from which it is abundantly distinct by the longer form, different prothorax, stouter and more strongly toothed thighs. The transverse impression of the elytra near the base is rather stronger than in *D. luridus*, and very much as in *D. subsignatus*, with which it agrees except in the form of the prothorax.

8. **D. squamosus**. *Anthonomus* ‡ *tessellatus* | Walsh, Proc. Ent. Soc. Phila. vi, 267.

Piceous, or ferruginous, mottled with pale depressed scale-like hairs. Beak as long as the head and prothorax, not striate, punctured, nearly smooth at tip. Prothorax a little wider than long, densely punctured, sides rounded in front, and slightly constricted. Elytra one-third wider than the prothorax, convex, striæ rather coarsely punctured. Thighs rather slender, tooth small.

Illinois and Kansas: bred by Mr. B. D. Walsh from galls which occur on willow. Mr. Walsh recognized the resemblance in form to *Erirhinus*, but unfortunately misplaced this species, in which the claws are simple and divergent.

9. **D. Mannerheimii**. *Erirhinus Mann.* Gemminger, Col. Hefte, viii, 122; *Erirhinus vestitus* | Mann., Bull. Mosc. 1853, ii, 242.

Alaska, one specimen, Prof. Mäklin; British Columbia. Quite distinct from the other species in our fauna by the uniform coarse gray pubescence, and the punctured beak; the prothorax is a little wider than long, suddenly narrowed, rounded and feebly constricted near the tip. Length 2.5 mm: .10 inch.

10. **D. hirtus**, n. sp.

Brownish yellow, or fulvous, clothed with coarse yellow hair, which is mixed with longer hairs on the elytra. Beak as long as the head and prothorax, finely punctured, feebly striate near the base, marked between the antennæ with an elongate fovea. Prothorax transverse, one-half wider than long, rounded on the sides, suddenly narrowed, rounded and constricted near the tip; disc strongly not very densely punctured, obsoletely channeled. Elytra wider than the prothorax, oblong elongate, humeri rounded; striæ composed of approximate square punctures, interspaces flat, sparsely punctulate and rugose. Thighs armed with a small tooth. Length 3.5 mm; .14 inch.

One specimen, San Diego, Cal.

Digitized by Google

11. **D. hispidus**, n. sp.

Brownish yellow, clothed with coarse yellow hair, slightly mottled near the tips of the elytra, and mixed on the elytra with longer stiff suberect bristles. Beak as long as the head and prothorax, finely punctured, without striæ and without interantennal fovea. Prothorax strongly punctured, with an indistinct smooth dorsal line; one-half wider than long, rounded on the sides; suddenly rounded, narrowed, and very feebly constricted near the tip. Elytra oblong elongate, wider than the prothorax, humeri rounded, striæ composed of approximate punctures, interspaces wide, flat, sparsely punctulate. Thighs armed with a small tooth. Length 3.5 mm; .14 inch.

One specimen, New Mexico. Very similar to the preceding, but sufficiently distinct by the suberect bristles of the elytra, the prothorax less constricted at the tip, and the beak without a fovea between the antennæ.

Group II. Desmorhines.

In the genera constituting this group the beak is slender, and separated from the head by a sharply defined transverse line, or constriction. In our genera the claws are connate at base, but as this character is not mentioned in the European genus *Sharpia* (Tournier, Ann. Ent. Belg. xvii,) and is somewhat variable in *Smicronyx*, I do not know that it is properly of group value. The mandibles are truncate at tip, and toothed both on the inner and outer edge as in *Rhynchitidæ*. The prosternum is emarginate in front, and the ventral sutures are very slightly curved at the sides. The antennal grooves descend obliquely and are almost confluent behind.

Antennæ with first and second joints of funicle elongated...	2.
Antennæ with second joint of funicle scarcely longer than third...	3.
2. Antennæ slender, club small, oval......................	DESMORIS.
" stouter, club larger, elongate oval......	PACHYTYCHIUS.
3. Claws small, frequently connate nearly to the tip	SMICRONYX.

DESMORIS n. g.

This genus corresponds closely with *Erirhinus*, except in the differences indicated in the definition of the group, viz., the connate claws, the oblique antennal grooves which are nearly confluent behind, and the beak constricted at base. The second joint of the funicle is as long as the first, but more slender. The thighs are clavate, unarmed. The tibiæ slightly mucronate and truncate at tip, nearly as long as the thighs; tarsi dilated, third joint deeply bilobed, fourth joint long; claws small, connate nearly to the tip.

The appearance is that of *Balaninus* in miniature, the eyes are rather large and transverse, the sides of the prothorax scarcely lobed, and the prosternum moderately emarginate in front; the prothorax is rounded on

Digitized by Google

the sides, narrowed in front, feebly constricted near the tip; the elytra wider than the prothorax, striæ deep, slightly punctured, interspaces flat. The beak is one-half longer than the head and prothorax, and is separated from the head by a deep transverse impression.

Scape of antennæ not attaining the eyes........................ **1. scapalis.**
" " nearly " " .... **2. constrictus.**

1. **D. scapalis**, n. sp.

Dark-brown, densely clothed with whitish scales. Beak strongly punctured, antennæ slender, with the scape not reaching the eyes, inserted about the middle of the beak. Head sparsely punctured, separated from the beak by a sharp transverse impression. Prothorax densely punctured, very convex, not longer than wide, much rounded on the sides, narrowed in front, and constricted at the sides at a greater distance from the tip than usual, base nearly straight. Elytra one-half wider than the prothorax, convex, feebly emarginate at base, humeri prominent, rounded; striæ deep, strongly punctured, interspaces flat, sparsely rugosely punctured. Thighs strongly clavate. Length 4.5 mm.; .17 inch.

One specimen, Kansas. Larger than the next, and easily known by the short antennal scape, which fails to reach the eyes by a length equal to the first joint of the funicle.

2. **D. constrictus.** *Rhynchænus constr.* Say, Journ. Ac. Nat. Sc. Phila. iii, 313; ed. Lec. ii, 176; *Balaninus constr.* Say, Curc. 26; ed. Lec. i, 294; Sch. Curc. vii, 293; *Erirhinus constr.* Gyll., Sch. Curc. iii, 286.

Kansas and Missouri, not rare. The beak is not quite so long in ♂ as in ♀; it is punctured in the former, and squamose behind the antennæ; in the latter it is glabrous, except at the base, and smooth except on the sides near the base. Smaller than the preceding, with the sides of the thorax less rounded; the color is blackish, with the antennæ and legs dark ferruginous. Either of these species will agree with the descriptions of Say and Gyllenhal. The latter author does not mention the transverse constriction at the base of the beak.

PACHYTYCHIUS Jekel.

The species which I have referred to this genus are rather convex and stout insects, having the sides of the prothorax and elytra rounded. They agree with *Desmoris* in having the second joint of the funicle elongated, but the antennæ are stouter, and the club larger. They differ from *Smicronyx* chiefly by the second joint of the funicle being obviously longer than the third. The claws are connate for one-half their length.

Elytra mottled with spots of gray scales..................... **1. amœnus.**
" with broad white margin............................... **2. discoideus.**

1. **P. amœnus.** *Tychius amœnus* Say, Curc. 26; ed. Lec. i, 294; Gyll., Sch. Curc. iii, 419.

Western States, and Lake Superior. A very robust species, clothed

Digitized by Google

with dark-brown scales; the prothorax has four whitish vittæ; the elytra a short basal line on each, and some narrow irregular whitish bands; the sides of the prothorax are much rounded and incurved at the base. The scales at the base of the beak form two little tufts as in the next species.

2. P. discoideus, n. sp.

Robust, black, clothed with white scales; disc of prothorax and elytra brown. Beak longer than head and thorax, not slender, curved, strongly punctured, not thickened towards the base, which is deeply transversely impressed; the scales form two small tufts near the transverse impression. Prothorax wider than long, very much narrowed in front, strongly rounded on the sides, which are incurved near the base, though less so than in *P. amœnus*, coarsely and densely punctured; disc brown for two-thirds the length, and one-half the width; with a whitish basal vitta. Elytra wider than prothorax, rounded on the sides, though less so than in the preceding; humeri rounded, but somewhat prominent; striæ fine, interspaces flat. Thighs clavate, claws connate for about one-half the length. Length 2.5 mm.; .10 inch.

New York, Illinois, Texas, and California. The discoidal spot of the elytra extends from the base for half the length and breadth; there is frequently a black lateral spot on the elytra, just behind the middle.

SMICRONYX Sch.

This genus contains small species which only differ from *Pachytychius* by the second joint of the funicle being shorter than the first, and frequently not longer than the third; the scape reaches to the eyes. The postocular lobes of the prothorax are sometimes distinct, and the prosternum is moderately emarginate in front. The beak is shorter than in *Desmoris*, and is slightly thicker at base; the transverse constriction is well defined, and the pubescence at the base of the beak rises into two tufts.

The form varies somewhat, the first species resembles *Pachytychius* by the strongly rounded sides of prothorax and ovate elytra; others resemble in miniature *Dorytomus*, but the thighs are not toothed, and the claws are small and connate almost to the tips. Others again have the claws approximate, but scarcely connate.

The genus, even as thus defined, seems to me somewhat heterogeneous, and with more careful study will be found perhaps, to contain elements representing other European genera. It will be for future investigators to determine if our species shall be partitioned, or the European forms condensed.

The species are difficult to define, and the table given is not very satisfactory.

Second joint of funicle of antennæ not longer than third; claws connate for more than half the length.................................. 2.

Second joint of funicle of antennæ longer than third; claws not connate, or feebly so.......................... .. . . 7.

Digitized by Google

2. Elytra ovate, rounded on the sides.............	3.
" oblong, parallel " "	4.
3. Prothorax transverse, scales yellow............	1. **corpulentus.**
" scarcely wider than long, scales gray	2. **ovipennis.**
4. Beak straight, scales gray.....................	5.
" curved................................	6.
5. Elytra suddenly wider than prothorax..........	3. **griseus.**
" gradually, slightly wider than prothorax	4. **obtectus.**
6. Of usual size, scales yellow, elytra rather broad..	5. **flavicans.**
Very small, scales grayish, elytra narrow.......	6. **pusio.**
Of usual size, mottled with spots of gray scales..	7. **tychioides.**
7. Interspaces of elytra not setose................	9.
" " with single rows of hairs..	8.
8. Of usual size and form........................	8. **vestitus.**
Smaller and more elongate.....................	9. **seriatus.**
9. Scales mottled in color........................	10.
" small, uniform bright fulvous............	10. **fulvus.**
" large, dirty gray........................	11. **sordidus.**
10. Elytra longer and less convex.................	12. **cinereus.**
" more convex, scales large, oval.........	13. **squamulatus.**
" " " " narrow............	14. **corniculatus.**

1. **S. corpulentus**, n. sp.

Robust, black, densely clothed with oval ochreous scales; beak densely punctured, slightly curved, as long as the head and prothorax, thinly pubescent. Prothorax nearly twice as wide as long, convex, sides strongly rounded, densely punctured, punctures obscured by the scales, disc darker than the sides. Elytra convex, sub-ovate, one fourth wider than the prothorax, humeri prominent, rounded, striæ well impressed, fine, interspaces flat; disc with a common dark spot extending from the base nearly to the middle, wider behind, and reaching the third stria. Antennæ with the funicle rather stout, second joint not longer than the third; hind tibiæ scarcely mucronate. Length 2.7 mm; .11 inch.

One specimen, Louisiana. Resembles in form *Pachytychius discoideus*, but easily distinguished by the generic characters, and the different color of the scales.

2. **S. ovipennis**, n. sp.

Robust, piceous black, thinly clothed with large gray scales; beak punctured, thinly pubescent, slightly curved, as long as the head and prothorax, Prothorax scarcely wider than long, rounded on the sides, narrower in front, convex, densely punctured. Elytra ovate, nearly one-half wider than the prothorax, humeri rounded, striæ deep, sparsely punctured, interspaces flat. Antennæ with the funicle rather stout, second joint not longer than third; hind tibiæ scarcely mucronate. Length 2.5 mm.; .10 inch.

Michigan, Kansas, Texas. The color of the scales is sometimes uniform,

Digitized by Google

sometimes mottled; it is easily recognized by the ovate elytra, which are distinctly wider at the middle than at the base.

3. **S. griseus**, n. sp.

Black, not very densely clothed with oval gray scales; beak longer than head and prothorax, less curved than usual; squamose towards the base. Prothorax without postocular lobes, slightly longer than wide, gradually narrowed from the base, feebly rounded on the sides, moderately constricted at the sides near the tip; not very convex, finely punctured. Elytra elongate, one-third wider than the prothorax, humeri not very prominent, broadly rounded: striæ impressed, punctured, not concealed by the scales. Antennæ and legs very dark-brown. Length 2 mm.; .08 inch.

Southern and Western States, Georgia to Kansas. This is probably *Micronyx cinereus* ‡ Dej., a name since used for another species.

4. **S. obtectus**, n. sp.

Black, very densely clothed with broadly oval yellowish scales, concealing the punctures; beak as long as the head and prothorax, curved; prothorax a little longer than wide, gradually narrowed in front, and constricted as in *griseus*, but more rounded on the sides, strongly, not densely punctured. Elytra of the same form as in *griseus*, striæ concealed by the scales, but when they are removed, deep and punctured, interspaces flat, nearly smooth. Legs and antennæ very dark-brown. Length 2 mm.; .08 inch.

California, found by me at San Diego.

5. **S. flavicans**, n. sp.

Piceous, clothed with small ochreous scales; beak slightly curved, as long as the head and prothorax, punctured, opaque, thinly pubescent. Prothorax a little wider than long, rounded on the sides, narrower in front, convex, densely punctured, postocular lobes broad, distinct. Elytra oblong, convex, sides parallel, then rounded at the tip; one-third wider than the prothorax, humeri prominent, rounded; striæ well impressed, interspaces slightly convex. Antennæ with second joint of funicle not longer than third, legs brown, hind tibia scarcely mucronate. Length 2.7 mm.; .11 inch.

Texas. Belfrage; one specimen.

6. **S. pusio**, n. sp.

Quite similar to *S. obtectus*, but very much smaller, with the scales broadly oval and very dense. The striæ of the elytra seem to be finer and somewhat nearer by pairs, the second and fourth interspaces appearing wider. Antennæ and legs dark-brown. Length 1.5 mm.; .06 inch.

Cape San Lucas; Mr. Xantus.

7. **S. tychoides**, n. sp.

More robust and convex, black, irregularly mottled with small whitish scales, which are of two forms, some being broad and some quite narrow. Beak curved, longer than head and thorax, punctured and scaly towards

Digitized by Google

the base. Prothorax a little wider than long, much rounded on the sides, narrowed in front, and not constricted, moderately punctured, punctures becoming granules at the sides. Elytra one-third wider than the prothorax, humeri rather prominent, less rounded, sides slightly rounded; scales thinly distributed with small spots more densely placed, striæ well marked, punctured, interspaces flat. Legs and antennæ dark reddish-brown. Length nearly 3 mm.; .11 inch.

Western States; Kansas, Texas. The elytra are sometimes reddish-brown, with the suture dark.

8. **S. vestitus**, n. sp.

Rather robust, convex, black, very densely clothed with grayish and yellowish, broadly oval scales, though scarcely mottled in color. Beak as in the preceding. Prothorax as wide as long, narrowed from the base forwards, rounded on the sides, not constricted near the tip; densely and strongly punctured, with a few scattered hairs mingled with the scales, which conceal the punctures, except where abraided. Elytra suddenly more than one-third wider than the prothorax; humeri rather prominent, sides slightly rounded, disc convex with well-marked finely punctured striæ, interspaces flat, each with a row of whitish hairs. Antennæ and legs ferruginous brown. Length 2.75 mm.; .10 inch.

One specimen, Kansas.

9. **S. seriatus**, n. sp.

More elongate, clothed with oval dirt-colored scales, not mottled. Beak as usual. Prothorax as long as wide, very little narrowed in front, broadly rounded on the sides, scales intermixed with white hairs, disc (when denuded) coarsely punctured. Elytra elongate, about one-third wider than the prothorax, sides not rounded, striæ deep, punctured, interspaces flat, each with a row of longish white hairs. Length 1.7 mm.; .07 inch.

Mariposa, California; Dr. A. Thevenet. When the scales are rubbed off the hairs remain giving the appearance of very sparse pubescence; an excellent instance of the necessity of indicating the specific differences in *Rhynchophora* from form and sculpture, rather than color and vestiture. I have a partially rubbed specimen from New York, which only differs by the scales being more white.

10. **S. fulvus**, n. sp.

Black, densely clothed with rather small bright fulvous scales. Beak longer than head and prothorax, nearly straight, smooth, and shining, slightly punctulate at base. Prothorax about as long as wide, broadly rounded on the sides, somewhat narrowed in front, and feebly constricted, post-ocular lobes scarcely distinct; finely and densely punctured. Elytra oblong, one-third wider than the prothorax, convex, striæ fine, punctured, interspaces nearly flat. Antennæ piceous, second joint of funicle a little longer than third. Legs reddish-yellow, hind tibiæ not mucronate, claws approximate, not connate. Length 2.5 mm.; .10 inch.

One specimen, Missouri; C. V. Riley. This species differs from the

Digitized by Google

others by the straight and nearly smooth beak. The ventral sutures are slightly yet distinctly curved. The form of body and the color of the scales gives a resemblance to *Sibynes*, from which it is abundantly distinguished by the simple claws.

11. S. **sordidus**, n. sp.

Black, elongate, densely clothed with rather small dirty gray scales. Beak as long as the head and prothorax, nearly straight, punctured, tip smooth and shining. Prothorax longer than wide, narrower in front, slightly rounded on the sides, postocular lobes wanting. Elytra oblong, humeri rounded, prominent, striæ fine, interspaces flat. Antennæ with the funicle rather slender, second joint longer than third. Claws rather large, approximate, not connate. Length 2 mm.; .08 inch.

Texas. Exactly resembles in appearance *S. griseus*, but differs by the larger claws, and more slender antennæ.

12. S. **cinereus** Motsch., Bull. Mosc., 1845, ii, 376.

California and Vancouver Island; G. R. Crotch; Dr. Thevenet. Easily known by its larger size (2.5 mm.; .10 inch), prothorax with rounded sides, and mottled color; a few short hairs are mingled with the scales, which are broad oval. The prothorax is thickly punctured, and distinctly constricted near the tip. The elytra are comparatively longer and less convex than in the neighboring species, thus producing a resemblance to *Dorytomus*.

13. S. **squamulatus**, n. sp.

Black, densely clothed with rather large oval gray scales, mottled with brown upon the elytra. Beak brown, longer than head and prothorax, slender, nearly straight, shining at tip, punctured and pubescent at the base. Prothorax as long as wide, rounded on the sides, narrower in front, postocular lobes not distinct. Elytra oblong, one-third wider than the prothorax, humeri rounded, prominent, striæ fine. Antennæ brown, with second joint of funicle scarcely longer than third. Legs brown, claws small, connate for about one-half their length. Length 2 mm.; .075 inch.

Two specimens, Detroit, Michigan; Messrs. Hubbard and Schwarz. An inconspicuous species, which may be easily recognized by the foregoing characters.

14. S. **corniculatus**. *Tychius corn.*, Fahræus, Sch. Curc. vii., 2d, 309.

Middle and Western States. A very small species, easily known by the narrow scales and rounded sides of the prothorax. Length 1.6 mm.; .065 inch.

Dark brown, not very densely clothed with narrow, small, whitish and yellowish scales. Beak as usual. Prothorax as long as wide, narrowed in front, much rounded on the sides, convex, densely and coarsely punctured. Elytra suddenly one-half wider than the prothorax, elongate, not rounded on the sides, striæ deep, punctured, interspaces flat. Antennæ and legs paler brown. Claws very small, partly connate.

Digitized by Google

Kansas; one specimen. A very small species, related to *S. tychioides*, and easily known by the narrow scales and rounded sides of the prothorax. The scales are partly abraded, but appear to be mottled in color.

Group III. **Eugnomi.**

Following the example of Lacordaire, I recognize as a distinct group a small number of genera which are closely related to the *Erirhini* proper, and like them have the antennal grooves directed against the eyes; they differ in having the eyes larger and more prominent, and separated from the margin of the prothorax by the head being more or less prolonged behind. The head thus recalls the form already seen in *Rhinomacer* and *Rhynchites*, though otherwise there is no resemblance.

The two species in my collection resemble in appearance small *Dorytomus* but the thighs are unarmed, and the second joint of the funicle of the antennæ is short.

I will for the present refer them to the genus *Phyllotrox*, though they differ from the description given by Lacordaire (Gen. Col. vi, 505), by the first ventral suture being well-marked.

PHYLLOTROX Sch.

1. **P. nubifer**, n. sp.

Elongate, fuscous, thinly clothed with golden pubescence; antennæ, legs and elytra fulvous, the latter with the suture and scutellar region more or less blackish. Length 1.8–2.3 mm.; .075–.09 inch.

San Francisco, California; collected by myself.

Beak rather stout, nearly as long as the prothorax, punctured, feebly channeled from between the antennæ for a short distance; eyes rather large, prominent; antennæ yellow, with the scape reaching to the eyes. First joint of funicle stout, and moderately long, followed by six short joints, club oval, pubescent. Prothorax not lobed behind the eyes, longer than wide, narrowed in front, feebly rounded on the sides, slightly constricted near the tip, rather densely punctured, thinly clothed with shining yellow hair. Elytra wider than the prothorax, elongate, humeri rounded, striæ with close-set punctures, interspaces densely punctulate, and sparsely pubescent, brownish-yellow, with the scutellar region and frequently the suture dark. Body beneath dark, strongly punctured; abdomen and legs brownish-yellow. Thighs not toothed, rather thick; tibiæ stout, truncate and not armed at tip, tarsi rather broad, third joint wider, deeply bilobed; claws simple, divergent.

This insect strongly resembles the figure of *Brachonyx indigena* Herbst, as given by Duval, Gen. Col. Eur. iv, pl. 19.

I have seen a variety from Colorado in the collection of Mr. Ulke, in which the color is bright yellow, only the head, trunk beneath, and the suture near the base of the elytra are dark.

2. **P. ferrugineus**, n. sp.

Smaller than the preceding, entirely ferruginous, sparsely pubescent,

Digitized by Google

Beak slender, curved, longer than the prothorax, sparsely punctured, eyes smaller, prominent; head punctured. Prothorax scarcely longer than wide, gradually narrowed in front, feebly rounded on the sides, slightly constricted near the tip, strongly not densely punctured. Elytra wider than the prothorax, humeri rounded, striæ deeper and more strongly punctured than in the preceding, interspaces more convex and less punctulate. Body beneath coarsely punctured. Length 1.5 mm.; .06 inch.

One specimen, Florida; collected by Dr. E. Brendel.

Group IV. **Cryptopii.**

In this group the body is densely clothed with scales, forming usually a shining crust; the beak is cylindrical and curved, not separated from the head by a transverse impression; the antennal grooves commence about one-third from the end, and run directly towards the eyes which are lateral, oval, transverse, coarsely granulated and not approximate beneath. Funiculus of the antennæ in some genera 6-jointed; first joint long, the others short, increasing gradually in breadth, and sometimes passing insensibly into the club, which is rather large, oval, annulated and pubescent. Prothorax with broad postocular lobes, front coxæ large, prominent, contiguous, prosternum transversely, very deeply impressed but not excavated in front of the coxæ, or deeply emarginate. The legs are not very slender, the thighs moderately clavate, the tibiæ sinuate on the inner side, as long as the thighs, truncate and mucronate at tip, with the articular surface terminal; the front tibiæ sub-serrate from the middle to the tip. Tarsi broad with the fourth joint short, variable in form (absent in the European *Anoplus*), third joint broad deeply bilobed. Elytra with ten entire striæ.

Last joint of tarsi broad, claws distant.................	2.
" " narrow, with one claw..............	BRACHYBAMUS.
" " " projecting, with two slender claws..	ONYCHYLIS.
Elytra slightly wider than the prothorax.............	ENDALUS.
" much " "	TANYSPHYRUS.

ENDALUS Lap.

This genus was first described by Schönherr, under the previously used name *Notiophilus*. The error was recognized and corrected in Vol. vii of his work, and the name changed to *Notiodes*. Meanwhile, however, *Endalus* had been proposed by Laporte, in a systematic work, and being accompanied by proper description must of course take precedence. The species occur on grasses near water; of those described thus far, only one properly belongs to the genus, the others will be found under *Onychylis* and *Lissorhoptrus*. The funicle is 6-jointed, and in some of the species passes gradually into the club.

Digitized by Google

The species form two groups, quite different in form, the elytra being very distinctly wider than the prothorax in the first.

A. Last joint of tarsi slightly prominent, claws moderately large, elytra wider than the prothorax.

Scales with bristles intermixed.......................... **1. setosus.**
" uniform, without bristles intermixed.......... **2.**
2. Prothorax not coarsely punctured.......................... **3.**
" coarsely punctured.......................... **4.**
3. Scales gray, length 4.5 mm .... **2. limatulus.**
" bronzed, " 2 mm.......................... **3. æratus.**
4. Prothorax scarcely wider than long. .... **4 cribricollis.**
" transverse, constricted in front.......... **5. punctatus.**

B. Last joint of tarsi not prominent; body oval.... ..... **6. ovalis.**

1. E. **setosus**, n. sp.

Dark brown, with scattered short erect bristles; prothorax broader than long, much rounded on the sides, suddenly narrowed and constricted at the tip, deeply and closely though not coarsely punctured, marked with four narrow lines of pale scales having a metallic lustre. Elytra a little wider than the prothorax, elongate; humeri rounded, not oblique, sides feebly converging behind, tip obliquely narrowed, uniform brown; striæ fine, interspaces feebly convex; sides as far as the eighth stria; and under surface, covered with pale scales; antennæ and legs ferruginous. Length 4 mm.; .16 inch.

Texas; Mr. Belfrage. The last tarsal joint is broad, and extends slightly beyond the lobes of the third joint; the claws are large and divaricate. The prothorax differs in form in the two sexes, in the same manner as in the next species.

Two smaller specimens are entirely similar to the preceding in form and sculpture, the elytra are covered with dirty gray scales, with a large common discoidal dark brown spot, extending from the base for four-fifths of the length, with prolongations on the third and fifth interspaces, causing the outline to be irregular; there are also two clouds on the sixth interspace, and one at the humerus. Length 3.5 mm.; .14 inch.

Middle States not rare; Kansas, Texas. The prothorax is much more rounded on the sides in the ♂ than in the ♀.

3. E. **limatulus** Lap., Hist. Nat. An. Artic. ii, 339 (1840); *Notiophilus lim.* Gyll., Sch. Curc. iii, 319; *Notiodes lim.* ib. vii, 2, 183.

4. E. **æratus**, n. sp.

Smaller, dark brown, covered with gray and brown scales having a metallic reflection; prothorax a little wider than long, sides rounded especially in front, tip narrowed and constricted, punctures deep and close, not coarse; disc with two brown vittæ. Elytra suddenly one-half wider than the prothorax, humeri oblique, obtuse, feebly rounded; striæ composed of approximate quadrate punctures, interspaces not convex, disc with a large

Digitized by Google

common brown cloud extending from the base thee-fourths the length; suture for the same distance blackish; beneath dirty gray. Length 2.3 mm.; .09 inch.

Two specimens, Texas: Mr. Belfrage. Tarsi as in the preceding species. In some specimens the variation in tint is scarcely apparent. and the whole upper surface is of a dull golden color.

5. **E. cribricollis**, n. sp.

Blackish brown, covered with grayish scales; prothorax subquadrate, scarcely wider than long, sides nearly straight, a little rounded near the tip, which is constricted; surface very coarsely and deeply punctured. Elytra suddenly one-third wider than the prothorax, humeri rounded, striæ deep, slightly punctured, interspaces nearly flat, disc with a faint brownish cloud behind the middle. Length 2.3 mm.; .09 inch.

One specimen, Georgia. The last tarsal joint is a little shorter, and the claws smaller than in the preceding species.

6. **E. punctatus**, n. sp.

Smaller and more robust than *E. cribricollis*, with the prothorax wider than long, more deeply constricted at tip, and somewhat less coarsely punctured. Elytra a little wider than the prothorax brown, with a darker sutural stripe; striæ deep, more distinctly punctured; legs dark testaceous. Length 1.8 mm.; .075 inch.

One specimen, Texas; Mr. Belfrage. The last tarsal joint and the claws still smaller than in *E. cribricollis*.

7. **E. ovalis**, n. sp.

Almost regularly oval, black, mottled with pale gray scales. Prothorax wider than long, narrowed from the base forwards, rounded on the sides, strongly constricted at the tip, surface deeply but not coarsely punctured, with three pale vittæ. Elytra very little wider than the prothorax; gray, with a abbreviated sutural stripe, and frequently some mottlings of dark brown; striæ deep, feebly punctured. Length 2.3 mm.; .09 inch.

New York and California. The color depends on the extent to which the crust of gray scales is preserved.

Several much smaller specimens from California, Florida and Lake Superior have the prothorax comparatively more coarsely punctured, but do not show any other difference. Length 1.5 mm.; .06 inch.

TANYSPHYRUS Sch.

This genus barely differs from *Endalus* by the funicle of the antennæ more slender, with the joints scarcely increasing in thickness; the prothorax narrower, and scarcely rounded on the sides; and the elytra fully one-half wider than the prothorax, truncate at base, with the humeri more prominent and slightly oblique. The last joint of the tarsi does not project beyond the lobes of the third, and the claws are distant and divaricated as in *Endalus*.

As Lacordaire observes, it resembles in miniature a *Grypidius*.

Digitized by Google

1. **T. lemnæ** Gyll., Sch. Curc. ii, 332; Duval, Gen. Col. Eur. iv. pl. 10; f. 47. *Rhynchænus lemn.* Fabr., Syst. El. ii, 455; cum mult. syn. Europ.

Detroit, Mich.; Messrs. Hubbard and Schwarz. A very small insect (1.2 mm.; .05 inch), of dull black color, mottled on the elytra with gray scales; antennæ and feet brown. It agrees so accurately with the description and figure of the European species that I am not warranted in considering it as distinct.

BRACHYBAMUS Germ.

The species mentioned below resembles in form *Bagous*, but is at once recognized by the last tarsal joint having but one claw; a very rare character, occurring in but two other genera in our fauna, *Mononychus* and *Barilepton*, which have otherwise no resemblance to this genus, nor to each other.

1. **B. electus** Germ., Sch. Curc. iii, 331; Boh., ibid. vii, 2, 185.

Middle and Southern States. The specimens in my collection agree fully with the detailed description last cited, but the prothorax is constricted near the tip, as described in the next. I think, however, that the differences mentioned are illusory, and that there is probably but one species in our fauna.

2. **B. inceratus** Boh., Sch. Curc. vii, 2, 186.

Boston; coll. Chevrolat. Unknown to me; said to differ from the preceding chiefly by the second interspace of the elytra being wider and somewhat elevated.

ONYCHYLIS n. g.

The species which constitute this genus are very similar to certain *Bagous* in form, size and sculpture, but differ by having the last tarsal joint comparatively smaller, and the claws slender and smaller. They also differ by having the articular surface of the hind tibiæ apical, and not lateral; the edge of the articular surface is fringed with small spines as in many *Erirhini*, and the spine at the inner side is long and slender, resembling at first sight the terminal hook of *Bagous*. The funiculus is 6-jointed; first joint longer and stouter, second a little longer than the third; 3–6 gradually a little broader, not merging into the club. The third joint of the tarsi is moderately dilated and bilobed; fourth joint extending beyond it.

Elytra without rows of setæ..	2.
Alternate interspaces with a row of distant setæ..........	**3. alternans.**
2. Body rather stout..	**1. nigrirostris.**
" more elongate..	**2. longulus.**

1. **O. nigrirostris** (Boh.) Sch. Curc. vii, 2nd, 184, (*Notiodes*).

Southern and Western States; Michigan to Florida. The beak is black, shining and naked in ♀; clothed with a dense coating of small scales in ♂; the anal segment frequently projects, and is visible beyond the elytra.

Digitized by Google

This species differs from the next by the stouter form, and the prothorax broader than long, more rounded on the sides, and more strongly constricted near the tip. Well preserved specimens are covered with a uniform crust of dirty gray scales; the middle of the prothorax and the disc of the elytra are most frequently abraded, so as to produce a pattern varying in extent and width. Too much care cannot be exercised in the study of the species of this and the next group, to avoid the deceptive influences of abrasion; the specific determinations should be always made upon form, structure and sculpture, disregarding color and pattern as of small importance. Length 3 mm.; .12 inch.

2. **O. longulus**, n. sp.

Black, covered with a uniform crust of dirty gray scales, as in the preceding species; antennæ testaceous, club fuscous. Prothorax as long as wide, slightly rounded on the sides, feebly constricted in front, very coarsely punctured, punctures barely visible through the scales. Elytra nearly one-half wider than the prothorax; humeri oblique, obtuse; sides parallel for two-thirds the length, then rounded to the tip; striæ well impressed, interspaces slightly convex, alternate ones slightly tesselated, without setæ. Length 3 mm.; .12 inch.

One specimen, Michigan; Messrs. Hubbard and Schwarz. Only differs from the preceding by the narrower form, and more coarsely though less distinctly punctured prothorax.

Without examination of the characters of the group and genus, this species might be readily confounded with *Lissorhoptrus simplex*.

3. **O. alternans**, n. sp.

Blackish, sparsely setose and covered with a mud colored crust; beak cylindrical, curved, as long as the head and prothorax; the latter wider than long, feebly rounded on the sides, slightly narrowed but not constricted in front, coarsely and thickly punctured. Elytra one-third wider, humeri oblique, prominent, disc rather flattened in front; striæ and punctures obscured by the crust, alternate interspaces distinctly elevated, and furnished with a row of distant rather long bristles; tibiæ rather stout, curved, with a moderate hook at tip; tarsi narrower than in the preceding species, so that the last joint seems to project farther, though it is not really longer. Length 2.5 mm.; 10 inch.

Texas; Belfrage; two specimens.

Group V. Stenopelmi.

This genus is included by Lacordaire in his group *Storeides*, but it seems to me that the remarkable combination of characters requires that it should be received as a separate group, with the following definition:

Body clothed with a dense crust of scales; beak short and broad, not longer than the head; antennal grooves very short. Antennæ inserted on the upper rather than the lateral surface, scape long, reaching to the back part of the eyes, which are round, and coarsely granulated; funiculus 7-jointed,

Digitized by Google

first joint longer and stouter, remaining joints short, closely united; club oval, pointed, entirely pubescent, annulated. Prothorax obliquely truncate in front, without postocular lobes, longer on the disc than at the sides; prosternum extremely short, not emarginate in front. Elytra much wider than the prothorax, humeri nearly rectangular. Ventral segments, first, second and fifth very large, third and fourth very short, last ventral suture slightly curved. Legs slender, thighs not toothed; tibiæ truncate at tip, very slightly mucronate; tarsi narrow, third joint not broader, slightly emarginate; fourth joint as long as the two preceding; claws slender, divergent.

This group diverges towards *Prionomerus* in the form of the head and antennæ, but otherwise has no resemblance to that genus.

STENOPELMUS Sch.

1. **S. rufinasus** Gyll., Sch. Curc. iii, 469; *Panscopus* ruf. Sch., ibid. vii, 2, 351; *Monius ruf.* Sch., ibid. (corrigenda) viii, 2nd, 501.

Southern and Western States, to California, where it was found abundantly by Mr. Crotch and myself at San Diego. The reason given by Schönherr for changing the name under which he first defined this genus is not a valid one. Even if there were in Dejean's Catalogue a genus *Stenopelmus* (which is not the case in the latest edition), it could have no precedence over the name as substantiated by description. The use of *Monius* to indicate this genus is therefore incorrect.

Group VI. **Brachypi.**

The genus *Brachypus* is placed by Lacordaire in his group *Erirhinides*; it differs from the other genera of that division by the narrow linear form. Though the three species described below, do not exactly agree with the generic description given by Schönherr and Lacordaire, I think that they accord sufficiently to indicate the propriety of associating them together as a special group.

As here established, the *Brachypi* are nearly related to *Hydronomi*, but differ by the third joint of the tarsi being more or less bilobed, and the hind tibiæ truncate at tip, not unguiculate, but only feebly mucronate, with the articular surface terminal. The tarsi are either broad or narrow, the third joint sometimes but little dilated, and the last joint long, with large divergent claws. The body is narrow, covered with a dense water-proof crust of scales, as in *Cryptopli* and *Hydronomi*. The beak is straight, cylindrical, moderately stout, and as long as the prothorax; the antennal grooves run directly to the eyes and converge but slightly behind; they commence at a varying distance from the mouth. The antennæ are slender; funicle 7-jointed, first and second joints elongated in our genera, 3–7 gradually broader, club oblong-oval, annulated, entirely covered with sensitive surface. Prothorax with large postocular lobes, prosternum deeply emarginate beneath, not excavated. Legs long, slender, thighs moderately clavate, front and middle tibiæ slightly sinuate, feebly mucronate at tip.

Digitized by Google

Tibiæ not serrate on the inner side........................ **ANCHODEMUS.**
Front and middle tibiæ serrate.............................. **LIXELLUS.**

ANCHODEMUS n. g.

I have established this genus upon three narrow species resembling in form the European *Bagous* (*Lyprus*) *cylindrus*, but quite different by the prosternum not being excavated, and by the tarsi broad and hairy, the first and second joints as wide as long, third wider, deeply bilobed; fourth as long as the two preceding united, claws large, divergent; antennæ inserted about one-fourth from the end of the beak, scape reaching the eyes; funiculus 7-jointed; first joint stouter, second equal in length to the first, 3–7 short and gradually broader; club elongate, annulated. Beak as long as the prothorax, not very slender, cylindrical; antennal grooves commencing one-third from the tip, scarcely attaining the eyes, which are large, transverse, and rather coarsely granulated. Prosternum broad, somewhat flattened, emarginate in front, not sulcate; postocular lobes distinct, coxæ large, prominent, with a deep transverse impression in front of the coxæ.

Scales brownish-gray, not mottled................................ **1. angustus.**
" grayish-white, " " .... **2. Hubbardi.**
" brown, elytra with a paler band......................... **3. Schwarzi.**

1 **A. angustus,** n. sp.

Elongate, blackish-brown, covered with a dirt-colored crust; beak slender, tip naked and shining; prothorax longer than wide, sides parallel, a little narrowed and rounded near the tip, which is constricted, base oblique each side, obtusely angulated at the middle. Elytra about one fourth wider than the prothorax and three times as long, humeri oblique, angulated; striæ punctured, interspaces nearly flat, each with a row of very small bristles. Tibiæ slender, slightly bent; apical hook small; antennæ and legs testaceous; second joint of funicle but little longer than first. Length 4 mm.; .15 inch.

Michigan, Hubbard and Schwarz; Illinois, Walsh; New York, Ulke. Greatly resembles in appearance *Hydronomus alismatis* of Europe.

2. **A. Hubbardi,** n. sp.

Elongate, black, covered with a dense crust of grayish-white scales. Beak, antennæ, and legs, yellow-brown. Beak as long as the prothorax, nearly straight, naked, shining, finely punctulate and slightly pubescent at the base, where it is finely carinate and feebly bisulcate; frontal fovea distinct. Prothorax not longer than wide, slightly rounded on the sides, distinctly constricted near the tip. Elytra about one fourth wider than the prothorax, humeri rounded, sides parallel, then obliquely narrowed, tips separately acuminate and rounded, and slightly thickened; striæ obscured by the scales, shallow and punctured. Antennæ with the second joint of the funicle twice as long as the first. Tarsi with the third joint bilobed, scarcely wider than the second. Length 7.5 mm.; .30 inch.

Detroit, Michigan; Messrs. Hubbard & Schwarz. A fine species, of large size for the tribe to which it belongs.

Digitized by Google

3. A. **Schwarzi**, n. sp.

Elongate, brown, densely clothed with brown scales; prothorax trivittate with paler; elytra clouded with pale, and with a broad conspicuous common angulated band behind the middle, having the angle at the suture directed forwards. Beak as long as the prothorax, stouter than in the other two species, straight, densely punctured, slightly pubescent, not shining. Prothorax a little longer than wide, very slightly rounded on the sides, not constricted in front. Elytra more than one-third wider than the prothorax, humeri oblique, slightly rounded; striæ fine, well impressed, finely punctured; tips conjointly rounded. Antennæ and legs yellow-brown; second joint of funicle scarcely longer than the first; third joint of tarsi broad, bilobed. Length 4.5 mm.; .175 inch.

One specimen, Detroit, Michigan; Messrs. Hubbard & Schwarz. Easily recognized by the stouter beak, and conspicuous paler band of the elytra.

LIXELLUS n. g.

A small species of still narrower form constitutes this genus. It has precisely the appearance in miniature of a slender *Lixus*, and differs from *Anchodemus* by the third joint of the tarsi being not wider than the second, and not bilobed; the fourth tarsal joint is as long as the others united, and the claws are large and divergent. The thighs are less clavate, the tibiæ strongly bent, and the front and middle pairs are serrate on the inner edge from the middle to the tip; they are all feebly mucronate at tip. The beak is shorter than the prothorax, rather stout, nearly straight, and the antennal grooves commence near the tip; the funiculus is 6-jointed, with the first and second joints longer, the joints 3–6 short, slightly wider, club elongate oval, acute, annulated, pubescent.

L. **filiformis**, n. sp.

Very elongate, cylindrical, black, covered with extremely small brown scales, mottled in color. Beak opaque, punctulate, and scaly. Prothorax longer than wide, feebly constricted in front, sides nearly straight, very densely punctulate. Elytra little wider than the prothorax, striæ punctured, interspaces flat; tips conjointly rounded; antennæ and legs yellow-brown. Length 4.3 mm.; .17 inch.

One specimen from Canada, and one from Oregon.

Group VII. **Hydronomi.**

The same varnish-like covering noticed in the three preceding groups is retained in this, the species of which are also found on plants near water. They are easily distinguished by the longer and more slender legs, the tibiæ curved, and frequently serrate on the inner side and strongly hooked at tip. The tarsi are usually slender, the third joint frequently not dilated, and the last joint moderate or very long, with stout, simple, divergent claws. The prosternum is usually broadly sulcate.

Digitized by Google

Our genera may be tabulated as follows:

Club of antennæ entirely sensitive.......... .... 2.

" " partly smooth and shining; prosternum not excavated.................................. LISSORHOPTRUS.

2. Prothorax feebly constricted in front.............. BAGOUS.

" very strongly constricted in front.... PNIGODES.

LISSORHOPTRUS n. g.

This is the genus indicated without characters, and not named by Lacordaire.* It is founded upon *Bagous simplex* Say. It differs remarkably from the other genera of the group by the antennæ, the club of which is smooth and shining for two-thirds the length, and annulated only near the tip; the funiculus has but six joints, of which the first is stout, and the second a little longer than the others, which increase slightly in thickness. The prosternum is flattened, not excavated, transversely impressed in front of the coxæ, which are very large; tibiæ not very slender, somewhat curved, armed with a terminal hook. Tarsi narrow, last joint as long as the two preceding, claws slender, approximate. Beak stout, as long as the prothorax. Antennal grooves suddenly deflexed.

This is again a genus of transition, and only differs from *Onychylis* by the third joint of tarsi not emarginate, by the peculiar antennal club, by the tibiæ armed with stronger terminal hook, and the articular surface even of the hind pair lateral.

1. L. **simplex**. *Bagous simplex* Say, Curc. 29; ed. Lec. i, 297; *Bagous egenus* Gyll., Sch. Curc. iii, 549; *Notiodes eg.* ibid. vii, 2, 184.

Middle and Southern States to Texas. Say's description is far from sufficient.

2. L. **apiculatus**. *Notiodes apiculatus* Gyll., Sch. Curc. iii, 320.

Southern States and Texas. Only differs from the preceding by the usually larger size, and by the transverse impression at the middle of the sides of the prothorax being wanting.

BAGOUS Germ.

The essential characters of this genus consist, in my opinion, in the tibiæ being slender, strongly curved and armed at the tip with a strong hook, so that the articular surfaces become lateral; the tarsi are narrow, not spongy beneath, though the third joint is sometimes wider and emarginate. The claws are divergent, sometimes rather large. The club of the antennæ is entirely pubescent, sensitive, and larger than usual; the antennal grooves are deep and extend to the eyes; the beak varies in form. The prosternum is broadly and deeply excavated in front of the coxæ, and the groove is sharply limited at the sides by ridges; the postocular lobes are large.

* Gen. Col. vi, 489, note 2.

Digitized by Google

The species may be thus separated:

Third joint of tarsi broader, emarginate.........	2.
" " narrow, not emarginate......	5.
2. Elytra each with one posterior tubercle.........	3.
" " two " tubercles.......	1. **mammillatus.**
3. Interspaces equal, flat, or nearly so.............	4.
Alternate interspaces more elevated.............	2. **sellatus.**
4. Scales uniform pale gray, striæ less deep........	3. **planatus.**
" gray and dark brown; striæ deeper......	4. **obliquus.**
5. Tarsi very long, prothorax finely rugose........	5. **americanus.**
" short; prothorax scarred with deep impressions..................................	6.
Tarsi short, or moderate, prothorax strongly granulate	7.
Tarsi short, or moderate, prothorax feebly granuulate	8.
6. Front deeply excavated, beak tricarinate.,......	6. **cavifrons.**
" foveate, beak tricarinate..................	7. **magister.**
7. Elytra clouded with darker scales; beak long, tarsi short..................................	8. **nebulosus.**
Elytra uniform in color; beak short, tarsi long..	9. **californicus.**
" with a white spot behind, beak short, tarsi long..	10. **restrictus.**
Elytra with a broad black band, beak short, tarsi long..	11. **pusillus.**
8. Prothorax not transverse......................	12. **bituberosus.**
" wider than long, much constricted in front....................................	13. **transversus.**

1. B. **mammillatus** Say, Curc. 28, ed. Lec. i, 297; Gyll., Sch. Curc. iii, 539.

Southern and Western States. Varies in size from 2.4–3 mm.; .09–1.3 inch.

2. B. **sellatus**, n. sp.

Black; head, three thoracic vittæ, sides and tip of elytra densely covered with cinereous scales, leaving a large elongate common triangular space black. Prothorax a little longer than wide, coarsely granulate, sides parallel, suddenly constricted near the tip. Elytra with the humeri oblique and obtusely angulated, striæ deep, interspaces convex, first, third, and fifth more elevated, the last terminating in a large conical tuberosity, which is surrounded behind by a dark cloud. Beneath fuscous, thighs with a ring of paler scales. Tarsi with the third joint broader, emarginate. Length 2.5 mm.; .10 inch.

One specimen, Georgia. The common triangular spot extends from the humeri to the suture upon which it ends at about two-thirds the length; there is also on each elytron a marginal cloud behind the humerus, and a small subapical one behind the large tuberosity.

Digitized by Google

3. **B. planatus**, n. sp.

Black, uniformly and densely clothed with dark cinereous scales. Beak punctured, nearly naked, stout, curved, nearly as long as the prothorax; the latter is a little longer than wide, sides parallel, suddenly constricted near the tip, disc coarsely granulate, feebly channeled. Elytra wider than the prothorax, humeri less oblique, angulated, more prominent, striæ fine, interspaces very flat, fifth with a conical tubercle on the posterior declivity, third with an obsolete elevation at about two-thirds the length. Antennæ and feet dark testaceous; tarsi with third joint broader, emarginate. Length 3 mm.; .12 inch.

Lake Superior and New York. Related to *B. mammillatus*, but the striæ of the elytra are finer, the interspaces still more flat, the tubercles much smaller, the anterior one being hardly apparent, and the scales purer gray, approaching lead color.

4. **B. obliquus**, n. sp.

Rather elongate, black, variegated with pale and dark-brown scales. Beak as long as the prothorax, stout, curved, flattened above, lateral grooves not deep; front with a short impressed line. Prothorax longer than wide, broadly constricted at some distance from the tip; coarsely granulated, dark brown with a broad pale lateral stripe. Elytra nearly one-half wider than prothorax, humeri oblique, rounded, posterior callus not very prominent, apex oblique, narrowly rounded; striæ deep, interspaces slightly convex; dark brown, with an oblique pale band commencing at the humerus and reaching the suture a little behind the middle; there are also a few pale spots on the third and fourth interspaces. Antennæ and legs brown, third joint of tarsi a little wider, emarginate; claws small. Length 2.3 mm.; .09 inch.

Detroit, Michigan, and Florida; Messrs. Hubbard and Schwarz; many specimens. The prothorax varies slightly in form; the sides are nearly straight behind, and usually parallel; sometimes, however, they converge slightly, so that the widest part is in front of the middle. The last joint of the tarsi is shorter and the claws smaller than in *B. planatus*.

5. **B. americanus**, n. sp.

Elongate, black or brown, covered uniformly with silvery-gray scales; prothorax longer than wide, sides feebly rounded, a little narrowed and broadly constricted near the tip, obscurely granulate. Elytra wider than the prothorax, humeral angles obtuse, almost rounded, striæ fine, distinctly punctured. Antennæ and legs testaceous, the latter long and slender, tibiæ strongly hooked, curved and armed with a row of small distant teeth on the inner face. Tarsi longer than usual, joints 1–3 equal, fourth equal to the two preceding. Length 4 mm.; .16 inch.

Middle States and Canada. I have adopted the name given in Dejean's Catalogue. Easily known by its large size and elongate form; there is a marked difference in the beak of the two sexes; that of the male is stout, shining, very finely punctulate, not longer than the prothorax, and about

Digitized by Google

one-half as wide as the head; in the female it is slender, one-third longer, and with the antennæ inserted about the middle of the length.

6. B. **cavifrons**, n. sp.

Black, covered with slaty-black scales. Beak shorter than the prothorax, rather stout, scarcely curved, flattened above and finely tricarinate, lateral grooves deep; front deeply excavated between the eyes. Prothorax longer than wide, gradually slightly narrowed in front, constricted near the tip, sides not rounded; undulated by deep, distant anastomosing grooves, of which the most conspicuous forms a dorsal channel; surface not coarsely granulated. Elytra nearly one-half wider than the prothorax, humeri oblique, scarcely rounded, sides converging behind, tip more elongated and more narrowly rounded than in the next species; posterior callus prominent, striæ punctured; interspaces broad, slightly uneven, each with a row of very short whitish bristles; each side just behind the middle is a small oblique spot of white scales, extending from the fifth to the second stria. Antennæ and legs nearly black; tibiæ long, much curved; tarsi short, slender. Length 4.3 mm.; .17 inch.

Enterprize, Florida; May; one specimen; Messrs. Schwarz and Hubbard. Closely related to the next, but differs by the deeply excavated front, and elytra more narrowly rounded at tip.

7. B. **magister**, n. sp.

Blackish-brown, covered with dark-brown scales. Beak as long as the prothorax, rather stout, slightly curved, somewhat flattened above, and feebly tricarinate, lateral grooves deep; front with an elongate large fovea between the eyes. Prothorax longer than wide, sinuate on the sides, more narrowed towards the tip, and deeply constricted; surface deeply sculptured with anastomosing grooves, with a broad dorsal channel behind the middle; not coarsely granulated. Elytra nearly one-half wider than the prothorax, more oblong than in *B. cavifrons*, humeri less oblique and more rounded, tips more obtusely rounded; posterior callus prominent; striæ coarsely punctured; interspaces slightly convex, each with a row of very short distant bristles; just behind the middle is a transverse spot of pale scales extending from the fifth to the third stria; the alternate interspaces are variegated with pale-brown spots. Antennæ and legs nearly black; tibiæ less slender than in *B. cavifrons*, tarsi a little longer. Length 5 mm.; .20 inch.

Texas, Belfrage: Detroit, Hubbard and Schwarz; Canada.

8. B. **nebulosus**, n. sp.

Rather robust, black, clothed with dirty gray scales, variegated with darker and paler. Beak slender, curved, finely punctulate, naked, except at base, as long as the prothorax; front feebly channeled. Prothorax wider than long, coarsely granulated, sides nearly straight for more than two-thirds the length, then obliquely narrowed and feebly constricted. Elytra less than one-half wider than the prothorax, oblong, impressed obliquely behind the base; humeri prominent, rounded, tips broadly

Digitized by Google

rounded, separately sub-acuminate; striæ punctured, interspaces slightly convex, each with a row of rather long reclinate bristles; posterior callus not prominent. Antennæ and legs dark; tarsi short. Length 3.2 mm.; .125 inch.

One specimen, Point Huron, Mich.; Hubbard and Schwarz.

The markings of the elytra are not very distinct; the most conspicuous is a pale stripe extending on the fifth and sixth interspaces from the oblique impression to behind the middle, where it is flexed rectangularly and runs to the suture.

9. B. **californicus**, n. sp.

Rather robust, black, clothed with dark-gray scales of uniform color. Beak stout, curved, shorter than the prothorax, scaly; frontal fovea not deep. Prothorax wider than long, coarsely granulated and rugose; sides straight, diverging slightly from the base for two-thirds the length, then rounded and narrowed to the tip, where it is strongly constricted; with a broad dorsal channel near the base. Elytra nearly one-half wider than the prothorax, humeri oblique, slightly rounded; sides parallel, then obliquely narrowed, and narrowly rounded at the tip; disc flattened from the suture to the third stria, and from the base for three-fifths the length, striæ fine, interspaces slightly convex; posterior callus prominent; there is a feeble tubercle on the third interspace at about two-thirds the length. Antennæ and legs reddish-brown; tarsi long. Length 2.8 mm.; .11 inch.

One specimen, San Diego, Cal.; G. R. Crotch.

Differs from *B. restrictus* by the tubercle on the third interspace behind the middle, and by the absence of the white spot which occupies a similar position in that species.

10. B. **restrictus**, n. sp.

Black, covered with dirt-colored scales, beak subcarinate, nearly as long as the prothorax; the latter as wide as long, slightly wider from the base forwards, with the sides straight, for three-fourths the length, then rounded and suddenly constricted, more strongly than in the other species; coarsely granulate. Elytra with the humeri oblique, obtusely angulated, less prominent, striæ deep, interspaces convex, fifth terminating in a small conical tubercle, covered with white scales; there is also a small transverse white spot on the second and third interspaces at about two-thirds the length. Antennæ tibiæ and tarsi brown, third joint not dilated, fourth longer than the two preceding united. Length 2.5 mm.; .10 inch.

One specimen; Texas; Belfrage. The tarsi are more slender than in the neighboring species.

11. B. **pusillus**, n. sp.

Less robust, black, clothed with dirt-colored scales, elytra with a broad toothed transverse band behind the middle. Beak stout, curved, as long as the prothorax, scaly, frontal fovea faint. Prothorax about as wide as long, sides straight, suddenly rounded, narrowed and strongly constricted near the tip; coarsely granulated. Elytra nearly one-half wider than the

Digitized by Google

prothorax, humeri prominent, oblique and rounded, sides nearly parallel, then oblique, tips rather broadly rounded, posterior callus small, very prominent; striæ fine, interspaces nearly flat. Antennæ and legs brown, tarsi long. Length 1.8 mm.; .07 inch.

Capron, Florida; Hubbard and Schwarz; one specimen.

The black band extends forwards to beyond the middle on the third, fourth and fifth interspaces, and is prolonged backwards on the fifth and sixth, as far as the callus.

12. B. **bituberosus**, n. sp.

Black, covered with dirt-colored scales. Beak stout, shorter than the prothorax, which is of the same form as in the preceding, feebly channeled and more finely granulate. Elytra wider than the prothorax, humeri less oblique, obtusely angulated, prominent; striæ deep, interspaces convex, fifth more elevated behind, and terminating in a large tuberosity; the third is a little wider and more convex than the adjoining ones. Antennæ, tibiæ and tarsi dark testaceous; third joint not dilated, fourth as long as the two preceding united. Length 3 mm.; .12 inch.

One specimen, Kansas; and one from Florida.

13. B. **transversus**, n. sp.

Robust, less convex, black, covered with blackish-gray scales. Beak stout, curved, as long as the prothorax, naked, punctulate, sub-carinate near the base, lateral grooves deep; frontal fovea large. Prothorax nearly one-half wider than long, sides sinuate, very strongly constricted in front, very finely granulate. Elytra uneven, marked with vague impressions, one-half wider than the prothorax, humeri prominent, slightly rounded, posterior callus large, obtuse; striæ fine, interspaces feebly convex. Antennæ and legs nearly black, tarsi moderately long. Length 2.3 mm.; .15 inch.

Detroit, one specimen; Hubbard and Schwarz. Remarkable for the form of the prothorax, by which an excellent transition to the next genus *Pnigodes* is established.

PNIGODES n. g.

This new genus is closely related to *Bagous*, and has the prosternum similarly excavated. There is also no difference in the beak, which is stout and curved, nor in the antennæ, which have the funicle 7-jointed; the first joint is stouter and the second longer than the others, which increase gradually in thickness, and the club is pubescent and annulated. The legs are stouter than in *Bagous*, the tibiæ sinuate on the inner side, hooked at tip; the tarsi rather short, joints 1–3 equal, fourth nearly as long as the others united, claws divergent.

The form of body is, however, remarkable. The prothorax is wider than long, narrowed behind, widely lobed on the sides before the middle, then suddenly and very strongly constricted and tubulate. The elytra are wider than the prothorax, with the alternate interspaces elevated, and a callus at the hind extremity of the fifth; the humeri are very prominent and rounded, not angulated.

Digitized by Google

1. **P. setosus**, n. sp.

Black, covered with a dirt-colored crust; prothorax deeply and broadly channeled; elytra finely striate with the alternate interspaces elevated, and bearing each a row of long bristles; a transverse common pale spot is seen behind the middle, extending from the suture to the third stria. The antennæ and legs are brown. Length 2.4–2.8 mm.; .09–.12 inch.

Texas, Belfrage; two specimens.

Group VIII. **Phycocœtes.**

This group is established upon one small species of pale brown color, which lives under sea-weed cast up by the waves at San Diego, California. It differs greatly from all the other members of the tribe, by the front coxæ which are not absolutely contiguous, but separated by a very narrow lamina of prosternum, and by the very short metasternum, only one-third the length of the first ventral segment.

In color, form and sculpture it resembles *Emphyastes*, but differs from that genus by such strong structural characters, that I cannot venture to place them together in one tribe.

Body clothed with very sparse pubescence. Beak cylindrical, slightly curved, as long as the prothorax, not very slender; mandibles of normal form; antennal grooves commencing near the tip, extending to the eyes, which are small, rounded, and coarsely granulated; front continuous with the beak. Antennæ with scape extending to the eyes, funicle 7-jointed, first joint stouter and longer, second nearly as long as the first, 3–6 rounded, seventh transverse, rounded; club rather small, oval, annulated, pubescent. Prothorax oval, longer than wide, rounded on the sides, not constricted nor lobed in front. Elytra oval, a little wider than the prothorax, humeri rounded, not prominent, base feebly emarginate. Prosternum rather long in front of the coxæ, flattened, not sulcate; joining the posterior point, so as to slightly separate the front coxæ which are large and globose. Mesosternum declivous, rather widely separating the middle coxæ; side pieces with the episterna very large, and the epimera very small, extending along the margin of the elytra. Metasternum very short, side pieces very narrow, but distinct; hind coxæ oval, very widely separated, extending to the margin of the elytra. Ventral segments, first longer than the second, separated by a sinuous suture; third and fourth united equal to second; fifth shorter than second, rounded at tip. Legs moderate, thighs clavate; tibiæ slender, nearly straight, slightly mucronate at tip, hind pair truncate, but without corbels; tarsi rather short, spongy beneath; third joint broader, deeply bilobed; fourth as long as the two preceding with rather large diverging simple claws.

The generic and group characters are combined in the above description.

PHYCOCŒTES n. g.

1. **Ph. testaceus**, n. sp.

Brownish yellow, darker beneath; above not very shining. Beak nearly smooth. Prothorax very sparsely punctured, with a hair proceeding from

Digitized by Google

each puncture. Elytra elongate oval, a little wider than the prothorax; striæ punctured, becoming obsolete behind; interspaces each with a row of well-marked distant punctures, from which proceed fine hairs. Beneath finely and very sparsely punctured. Length, 2.5 mm.; .10 inch.

San Diego, on the shore of the bay, under sea-weed. ♂ with the first and second ventral segments broadly concave; anal segments large, prominent.

Tribe VI. TRACHODINI.

The genus *Trachodes*, which occurs in Europe, Asia and Alaska, differs sufficiently from all others in our fauna to merit being placed in a separate tribe. Lacordaire classed it with the *Molytini*, which however seems an unnatural grouping of genera agreeing only in convex body, short metasternum, and absence of wings. The beak is rather slender, as long as the prothorax; the antennæ are inserted a little before the middle (♀), or one-third from the end (♂), rather slender, the scape reaching the inferior margin of the eyes, which are nearly round, coarsely granulated, and somewhat removed from the prothorax; the funiculus is 7-jointed, first joint elongate and stout, second nearly as long, but slender, 3–7 short, slightly increasing in thickness; club rounded oval, about one-half longer than thick, annulated, pubescent, tip rather pointed. Prothorax scarcely lobed, but ciliate behind the eyes. Epimera of metathorax narrow, entirely covered by the elytra; hind coxæ rounded, widely separated, not attaining the elytral margin. Ventral segments, first and second large, each as long as the metasternum, separated by a straight suture which is deeply impressed at the sides; third and fourth short, sutures straight; fifth as long as the two preceding united. Legs rather long, thighs pedunculated, not toothed; tibiæ slender, strongly hooked at tip; tarsi rather long, third joint wider, bilobed, last joint elongate, claws simple, slender, separate. Body rough with short erect bristles.

TRACHODES Germ.

Elytra uniformly convex without elevations:
Bristles of elytra not tufted.................. **1. ptinoides.**
Each elytron with two tufts of bristles....... **2. quadrituberculatus.**
Elytra with large elevations............... **3. horridus.**

1. T. **ptinoides** Germ., Sp. Nov. 327; Sch. Curc. iii, 513; Mann. Bull. Mosc. 1843, 293.

Alaska and Vancouver Island. I have received specimens of this species from Col. Motschulsky as his *T. fasciculatus*, Bull. Mosc. 1845, 2nd, 374.

2. T. **quadrituberculatus** Mann., Bull. Mosc. 1852, 355; *Sthereus quadr.* Motsch., ibid. 1845. ii, 375, Tab. vii, f. 4.

Alaska. The four tubercles of the elytra seem to me not elevations but bunches of bristles; they are situated on the third interspace; the first is about one-fifth from the base, and the second a little behind the middle; the elytral striæ are rather finer than in the preceding.

Digitized by Google

3. **T. horridus** Mann., Bull. Mosc. 1852, 354.

Alaska and Vancouver Island. The three rows of large elevations on each elytron easily distinguish this species.

Tribe VII. OTIDOCEPHALINI.

In all the preceding tribes the tarsal claws are simple, usually separate and divergent, rarely connate; in this, as in several of those which follow, they are toothed; the tooth, however, is broad and not very prominent, giving the form termed appendiculate. The species are easily known from those of other tribes by the prothorax being narrowed at base, and somewhat pedunculate. Several of them are shining black and glabrous, so that they resemble in appearance ants.

Mr. C. V. Riley, who has hatched several specimens of *Otidocephalus laevicollis* from the galls of *Cynips quercus-globulus*, informs me that they have a general resemblance to an apterous *Cynips*.

The other characters of the tribe and genus are as follows: Beak rather stout, straight, nearly as long as the prothorax, subcylindrical, not emarginate at tip; antennal grooves extending in front of the insertion of the antennæ, converging behind, directed below the eyes, which are distant from the prothorax, rounded, and finely granulated; mandibles of normal form, mentum and labial palpi small, gular peduncle narrow, long; antennæ inserted about one-third from the tip of the beak, scape long, slender, extending to the back part of the eyes; funicle 7-jointed; first joint stouter but only slightly longer than the second; 2–7 gradually a little wider, rounded; club oval pointed, pubescent, feebly annulated. Prothorax without postocular lobes; prosternum broad, short, not emarginate. Mesosternum very narrow between the coxæ, side pieces almost longitudinally divided. Metasternum long, side pieces very narrow. Ventral segments nearly equal, sutures straight, well marked, intercoxal process obtuse, moderately wide. Front coxæ rounded, prominent; middle coxæ rounded not prominent; hind coxæ oval, not extending to the elytral margin. Legs rather long, thighs somewhat clavate, usually toothed; tibiæ truncate at tip, not mucronate; articular surface terminal; tarsi dilated, spongy beneath, third joint broader, bilobed; claws divergent, more or less toothed. Elytra elongate-oval, convex, rounded at tip, entirely concealing the pygidium.

OTIDOCEPHALUS Chevr.

I have but one species to add to the synopsis given by Dr. Horn, in Proc Am. Phil. Soc. 1873, p. 448.*

O. dichrous, n. sp.

Dull ferruginous, with scattered white short hairs, prothorax one-half longer than wide, sides slightly rounded, narrowed behind, coarsely and

* *O. elegantulus* Summers, New Orleans, Our Home Journal, January 30th, 1875, and December 19th, 1875, does not belong to this genus, but to *Cylas*, a genus thus far known only from India and Africa. It will be found under the family *Brenthidæ*.

Digitized by Google

rather densely punctured. Elytra elongate oval, wider behind the base, striæ composed of approximate punctures, hairs short, not erect, distant, arranged between the striæ; dull ferruginous at base for onethird the length, then black. Beneath dull ferruginous, punctured, with sparse short white hairs, thighs armed with a small tooth. Length 5 mm.; .20 inch.

Florida, at Lake Harney and Enterprise, on old leaves of *Chamærops palmetto;* Messrs. Hubbard and Schwarz. Very distinct by the color and short, prostrate, sparse pubescence; differs from the Cuban *O. Poeyi* Chevr., by the distinctly dentate thighs.

Tribe VIII. MAGDALINI.

As the preceding tribe differs from all others with the front coxæ contiguous, by the pedunculate prothorax, so does this differ by the hind angles being prominent, and more or less produced over the base of the elytra.

The beak is slender, cylindrical, as long as the prothorax; the antennal grooves reach the lower edge of the eyes which are rounded and distant from the prothorax. Antennæ inserted near the tip, (♂), or about the middle of the beak ♀, slender, feebly geniculated; scape slender, slightly clavate, curved near the end, and usually attaining the eyes. Front coxæ contiguous, prominent; middle coxæ not widely separated; hind coxæ not very distant, small, oval, not extending to the elytral margin. Side pieces of mesothorax rather large, obliquely divided. Metasternum long, episterna rather wide; epimera visible behind, ventral segments unequal, first and second long, connate, with a faint undulated suture; inter-coxal process acute; segments 3–5 short, equal. Elytra oblong, not convex, widely separated at base by the scutellum, separately rounded at tip, exposing part of the pygidium. Legs moderate, thighs not clavate, sometimes toothed, tibiæ strongly unguiculate at tip; tarsi spongy beneath. third joint broader; bilobed; claws sometimes simple, sometimes toothed.

MAGDALIS Germ.

To the excellent synopsis of Dr. Horn, Proc. Amer. Phil. Soc. 1873, 452, I have but one species to add:

1. **M. aenescens**, n. sp.

Elongate, black bronzed, slightly pubescent; head, beak and prothorax densely finely punctured, the last longer than wide, rounded on the sides, which are serrate in front; hind angles small, prominent, base bisinuate, disc subcarinate in front of the middle. Elytra obliquely impressed behind the base, and also behind the middle; striæ composed of not very large punctures, interspaces finely rugose. Mesosternum not protuberant; thighs acutely toothed, claws distinctly toothed near the base. Length 3.7–5.6 mm.; .15–.22 inch.

Oregon, kindly given me by Mr. Ulke. Quite distinct by the color from all our other species. It should be placed between *M. barbita* and *olyra* in the synoptic table given by Dr. Horn.

Digitized by Google

Tribe IX. ANTHONOMINI.

This tribe is represented by a large number of species of small size, and constituting but few genera.

They may be distinguished by the following assemblage of characters:

Mandibles normal in form, gular peduncle long, mentum and ligula small. Beak long, slender, cylindrical; antennal grooves extending to the lower edge of the eyes, which are small, convex, rounded and distant from the prothorax, widely separated above, except in *Orchestes*, and a few species of *Anthonomus*. Antennæ inserted far from the tip of the beak, slender, scape long, funicle 6- or 7-jointed; club elongate-oval, pointed, entirely pubescent, and sensitive, very distinctly annulated, sometimes almost articulated, or divided into separate joints. Prothorax without postocular lobes, prosternum very short, not emarginate in front, coxæ contiguous, prominent. Mesosternum separating moderately the coxæ; side pieces diagonally divided. Metasternum moderately long, side pieces narrow, ventral segments separated by deep straight sutures, usually nearly equal; third and fourth segments short in *Alyca;* legs rather long; thighs frequently clavate and toothed; front and middle tibiæ with terminal hooks; hind tibiæ mucronate at tip, articular surface apical, and not lateral. Tarsi spongy beneath, third joint broad, bilobed, claws cleft, toothed, or appendiculate. The elytra are separately rounded at tip, so as to expose a portion of the pygidium in most of the species, but conjointly rounded in *Macrorhoptus* and *Alyca;* this exposure of the pygidium is however so slight in some species that it is evidently a character of no importance.

	Pygidium more or less exposed; claws toothed	2.
	" entirely covered....................	4.
2.	" and last ventral of ♂ normal......	3.
	" of ♂ perpendicular, last ventral short, emarginate....	COCCOTORUS.
3.	Eyes rounded distant, hind thighs normal....	ANTHONOMUS.
	" approximate above, hind thighs thickened....................	ORCHESTES.
4.	Ventral segments nearly equal; claws toothed.	MACRORHOPTUS.
	" " very unequal; claws appendiculate..................................	ALYCA.

COCCOTORUS Lec.

This genus is established upon a species, remarkable as well for its habits as for the singular sexual characters of the ♂. In this sex, namely, the additional dorsal segment is large and perpendicular, or rather slightly inflexed, and the last ventral is broadly emarginate behind, so that at the middle it is shorter than the fourth segment. The elytra are more oblong than in *Anthonomus*, finely and densely pubescent, the striæ fine and the interspaces flat; at the base are two small tufts of hair on each side, and

Digitized by Google

the suture is also tufted with longer hairs. The antennæ are slender, the first joint of the funiculus larger and stouter; second slender, not so long, 3–7 short, but not increasing in thickness, club elongate, oval, pointed, articulated. Thighs moderately clavate, armed with an acute tooth; front tibiæ with a terminal hook, middle and hind tibiæ truncate; claws separate, with an acute tooth, shorter than in *Anthonomus* and not curved inwards.

1. **C. scutellaris.** *Anthonomus scut.* Lec., Proc. Ac. Nat. Sc. Philada. 1858, 79; *Anth.? prunicida* Walsh, Prairie Farmer, June 13, 1863; Proc. Bost. Soc. Nat. Hist. ix, 309.

Illinois, Texas, Georgia.

The larva lives upon the kernel of the plum, like *Conotrachelus nenuphar*. Mr. Riley informs me that he has reason to believe that the egg is not pushed by the beak of the female deep into the fruit, as is the case with that species, but is laid on the surface, whence the larva, when first hatched burrows to the seeds.

Mr. Walsh very properly suspected that this insect should be separated as a distinct genus. I regret to have led him into error by not recognizing the species as identical with my previously described *A. scutellaris*, which was founded upon a much smaller specimen from a far distant locality.

ANTHONOMUS Germ.

The species of this genus are quite numerous, and although agreeing in the more important characters, differ in such manner as to indicate the propriety of future subdivision. For the purpose of making these subdivisions natural, a profound study of the exotic species will be necessary. I can at present merely mention some of the variant structures which I have observed.

The prosternum varies in length, being shortest in *A. elegans*, and longest in *A. rufipes* and *elongatus*. The fifth ventral segment is not longer than the fourth in most species, but in *A. elongatus* and some others of Division B it is quite distinctly longer and flatter, as in *Erirhinini*, and in these species the pygidium is not exposed. The ventral sutures are straight in most species, but the third and fourth are slightly curved in *A. conjunctus*, which thus shows a tendency towards *Tychius*. The claws are usually cleft, or armed with a long slender tooth; in certain species, as will be seen in the following table, the tooth is broad, or even so obtuse as to be indistinct. The funicle of the antennæ is usually 7-jointed, but in the species of Division C only six joints are observed.

These characters seem to be similar to those used by Lacordaire for separating the genera of *Anthonomini*, (Gen. Col. VI, 577), but on referring to the detailed descriptions, it will be found that in other respects the species in our fauna disagree. I, therefore, deem it more expedient to place them all in *Anthonomus*. The following table will enable most of them to be easily recognized.

Digitized by Google

A. Body above more or less pubescent, rarely with a few scattered scales. Funicle of antennæ 7-jointed.

	Elytra not tuberculate........................	2.
	Elytra tuberculate, first joint of funiculus very long, second short, front thighs bidentate.....	1. quadrigibbus.
2.	Funicle slender, first and second joints longer....	3.
	Funicle less slender, second joint equal to third..	6.
3.	Front thighs with a single tooth...............	4.
	" " bidentate:	
	Teeth confluent, elytra pubescent..............	2. nebulosus.
	Teeth separate, elytra with narrow pubescent markings................................	3. fulvus.
	One tooth and a small cusp; surface thinly pubescent, elytral striæ fine, head beneath squamose	4. gularis.
4.	Elytra with white markings..................	5.
	Ferruginous, elytral striæ deep, interspaces convex.....................................	5. profundus.
	Black, prothorax densely punctured, sparsely squamose	6 ater.
	Black, prothorax coarsely punctured, elytra brownish	7. brunnipennis.
5.	Black, middle and hind thighs not toothed......	8. scutellatus.
	Brown or testaceous, with a dark elytral band; all the thighs toothed.....................	9. signatus.
6.	Testaceous, rather densely pubescent...........	7.
	Thinly pubescent, elytra and legs ferruginous ..	8.
	Thinly pubescent, elytra partly or wholly black.	9.
	Very small, ferruginous, sparsely squamose......	21. pusillus.
7.	Thighs strongly toothed, elytra without spots....	10. rubidus.
	Thighs feebly toothed, elytra with a dark band..	11. juniperinus.
8.	Elytra opaque, prothorax very coarsely punctured....................................	12. sycophanta.
	Elytra shining, prothorax less coarsely punctured....................................	13. rufipennis.
9.	Elytra with a few small spots of pubescence......	10.
	Elytra uniformly, thinly pubescent, without spots	12.
10.	Front foveate................................	11.
	Front channeled.............................	16. sulcifrons.
11.	Elytra partly ferruginous, striæ coarse..........	14. suturalis.
	" reddish brown, striæ coarse............	15. musculus.
12.	Antennæ piceous, or nearly black..............	13.
	Antennæ yellow.............................	17. flavicornis.
13.	Elytral striæ coarsely punctured...............	14.
	Elytral striæ finely punctured.................	18. morulus.

Digitized by Google

14. Prothorax very coarsely punctured............ 19. nigrinus.
Smaller, prothorax less coarsely punctured...... 20. corvulus.

B. Body clothed above and beneath with dense scaly pubescence; funicle of antennæ 7-jointed.

Elytra at base suddenly wider than prothorax 2.
Elytra at base not wider than prothorax.......... 5.
2. Form robust................................ 3.
" elongate................................ 4.
3. Scales beautifully variegated.................... 22. elegans.
Scales uniform in color; second joint of funiculus longer than the third....................... 23. squamosus.
Elytra more or less vittate; 2d joint of funiculus scarcely longer than third.................. 24. tectus.
4. Pubescence more hair like, yellowish............ 25. hirtus.
Scales broad, whitish, thighs unarmed........... 26. inermis.
Scaly, striped, white and brown................. 27. subvittatus.
Scales grayish, thighs toothed.................. 28. pauperculus.
5. Funicle with second joint less elongate.......... 6.
" " " " more " .... 29. disjunctus.
6. Rather stout, legs ferruginous.................. 30. rufipes.
Elongate, legs brown........................... 31. elongatus.

C. Funicle of antennæ 6 jointed.

Claws with an acute tooth, as usual............. 2.
" scarcely toothed.......................... 7.
" with a short tooth........................ 8.
2. Elongate, pubescent............................ 3.
Elongate, densely squamose..................... 4.
Robust, clothed with scales..................... 34. robustulus.
3. Ferruginous, without lustre, prothorax with a dorsal line of more dense pubescence............ 32. cratægi.
Fuscous sparsely pubescent, elytra with two bands of small spots............................ 33. subfasciatus.
4. Scales uniform in color .... 5.
" mottled................................ 38. decipiens.
5. Second joint of funicle equal to third........... 6.
" " " longer.................. 39. canus.
6. Length 2 mm.................................. 40. affinis.
Length 1.5 mm; smaller and narrower........... 41. nanus.
7. Elongate, sprinkled with scales................. 35. nubilus.
" pubescent.......................... 36. ungularis.
8. Elytra fuscous, with a posterior sutural spot testaceous, and bands of white pubescence...... 37. mixtus.

Digitized by Google

1. **A. quadrigibbus** Say, Curc. 15; ed. Lec. i, 277; Sch. Curc. iii, 334.

Massachusetts, Illinois, Texas. Varies in size from 3 mm. (.125 inch) to 5 mm. (.2 inch); the larger specimens are more robust and have the elytral tubercles much more developed, and the interspaces more uneven. The beak of the ♀ is longer, that of the ♂ shorter than the body.

2. **A. nebulosus, n. sp.**

Dark, rufous, clothed with rather coarse ochreous pubescence; beak punctured, finely carinate, with two striæ on each side; head densely punctured. Prothorax closely and coarsely punctured, wider than long, narrowed in front, and broadly rounded on the sides, feebly constricted near the tip. Scutellum densely pubescent. Elytra at base one-half wider than the prothorax, oblong, striæ distant, not deep, coarsely punctured, interspaces feebly punctulate, shining; pubescence condensed so as to make a pattern of bands curving forwards and outwards, the spaces near the bands being nearly glabrous. Thighs strongly toothed, the front ones with a distinct acute cusp on the distal edge of the tooth; front tibiæ sinuate. Antennæ with the first joint of the funiculus equal to the three following; second equal to the two following united. Length 4 mm.; .15 inch.

Illinois and Missouri; three specimens. The pattern of the elytra is somewhat complex, and varies with denudation, but the other characters are quite sufficient to enable the species to be easily recognized.

3. **A. fulvus** Lec., Pr. Ac. Nat. Sc. Phila. 1858, 79.

Texas. A large species easily recognized by the shining fulvous color, very coarse punctures of the thorax, which has a narrow dorsal line of pubescence, and the pattern of narrow lines of pubescence behind the middle of the elytra. The striæ are scarcely impressed, distant and very coarsely punctured. The antennæ are as in the preceding, but the teeth of the front thighs are longer and separate.

4. **A. gularis, n. sp.**

Elongate, oblong, black, above with a few white hairs, head beneath, and sides of abdomen with dense white scales, beak finely punctulate, very obsoletely striate, head opaque, scarcely punctulate, with a small puncture between the eyes. Prothorax a little wider than long, rounded on the sides, narrowed in front of the middle, broadly constricted near the tip, convex strongly but not very closely punctured. Scutellum densely pubescent. Elytra about one-fourth wider than the prothorax, oblong, very dark red, with the suture blackish, striæ distant, well impressed, finely punctured, interspaces shining flat, nearly smooth. Antennæ ferruginous brown, joints as in the two preceding. Legs piceous, base of thighs, part of tibiæ and tarsi paler; thighs strongly toothed, front pair with a very

Digitized by Google

small acute cusp beyond the base of the tooth, and separate from it. Length 3.5 mm.; .15 inch.

One specimen, Middle States. Resembles in form and appearance *A. suturalis*, but is much larger, and the antennæ and front thighs are quite different.

5. **A. profundus**, n. sp.

Ovate, ferruginous, not shining, thinly and very finely pubescent; beak punctured and striate, head sparsely, distinctly punctured, with an impressed frontal line. Prothorax as long as wide, sides nearly straight behind, then rounded and narrowed in front of the middle, broadly constricted near the tip, convex, coarsely and tolerably densely punctured. Elytra with deep and wide punctured striæ, interspaces convex, finely rugose and punctulate. Antennæ as in the preceding species, with the second joint of the funiculus as long as the two following. Thighs acutely toothed, the front pair without accessory cusp. Length 3 mm.; .12 inch.

Illinois, two specimens. Larger and more robust than *A. sycophanta*, and easily known by the deep elytral striæ.

6. **A. ater**, n. sp.

Oblong, ovate, black, thinly pubescent above. clothed with white scales on the prothorax and beneath; beak long, slender, shining, sparsely punctured; head punctured, frontal line long and fine. Prothorax wider than long, narrowed in front from the base, sides broadly rounded, feebly constricted near the tip, closely punctured, punctures bearing white scales, which become larger and less sparse towards the sides. Scutellum white, pubescent. Elytra one third wider than the prothorax at the base, convex, striæ strongly impressed, punctured, interspaces slightly convex, rather shining, feebly rugulose. Antennæ piceous, scape and base of funiculus paler, second joint of latter equal to third and fourth united. Thighs armed with a small acute tooth, tibiæ and tarsi piceous. Length 4.5 mm.; .175 inch.

Geysers, California; Mr. Crotch.

7. **A. brunnipennis** Mannh., Bull. Mosc. 1843, ii, 292.

One specimen found with the preceding. An oblong species, resembling *A. suturalis* in form and size, with the beak punctured and striate, the head punctured, the frontal line long; the prothorax is a little longer than wide, very coarsely and densely punctured; the elytral striæ punctured, distant, not much impressed, the interspaces flat, nearly smooth. The antennæ are testaceous with piceous club, second joint of funiculus equal to third and fourth united. Legs slender, thighs very feebly clavate, armed with a very small acute tooth, almost obsolete on the hind pair; tibiæ nearly straight. Body thinly pubescent, with some intermixed scales towards the sides and on the under surface.

8. **A. scutellatus** Gyll., Sch. Curc. iii, 342.

Massachusetts, Texas, Missouri. Of the same size as the next species, and widely distributed.

Digitized by Google

The color is black, with the antennæ and tarsi testaceous; the front thighs are armed with a very small tooth, and the others are entirely unarmed. The markings are composed of scales, and in well preserved specimens the sides of the prothorax and the trunk are also squamose; a small post scutellar line and another each side at the base, and an indistinct prothoracic dorsal line are also whitish. The elytral markings stop suddenly at the eighth striæ, along which the front margin of the curve is prolonged, thus giving an oblique outline. The color varies and the elytra and legs are sometimes dark brown. I am in doubt whether this species is properly identified with the one intended by Gyllenhal. If the latter be not the one here described, it is probably nothing more than a dark variety of the next species, *A. subguttatus*, described below, also agrees moderately well, but the elytra are not piceous and the beak is not striate. If on examining the original type of *scutellatus* it is found that this species is distinct, it may be called *variegatus*.

9. **A. signatus** Say, Curc. 25; ed. Lec. i, 293; Gyll., Sch. Curc. iii, 348; Boh., ibid. vii, 2nd, 221, var. *A. bisignatus* Gyll., ibid. iii, 344.

Massachusetts to Florida and Texas; the black spot usually extends from the side two-thirds way to the suture, upon which in the best marked specimens, there is also a small dark spot; but it is frequently much smaller, extending only from the third to the sixth stria; the pubescence is denser at the margin of the spot which is thus surrounded with a hairy band. The thighs are all armed with an acute tooth. The second joint of the funiculus of the antennæ is perceptibly longer than the third, but not so much so as in the preceding species. It therefore forms a passage to the small species which compose the next group.

10. **A. rubidus**, n. sp.

Testaceous, uniformly clothed above and beneath with fine ochreous pubescence; beak punctured and striate, head sparsely punctured; prothorax wider than long, densely but not coarsely punctured, narrowed from the base, sides broadly rounded in front, feebly constricted near the tip, pubescence more condensed on the median line. Elytra one-third wider than the prothorax, oblong, striæ deep, moderately punctured, interspaces convex punctulate, scuttellar region somewhat dark, scuttellum white-pubescent. Thighs armed with an acute tooth; front tibiæ curved at base, sinuate on the inner side. Length 2.2 mm.; .09 inch.

One specimen, Pennsylvania; Dr. Melsheimer. Though agreeing in some characters, this species must be quite different from *A. helvolus* Boh. Sch. Curc. vii, 2,224, which is unknown to me.

11. **A. juniperinus**. *Erirhinus junip.* Sanborn, Proc. Bost. Soc. Nat. Hist., xii, 81.

Massachusetts, in Podysoma, a parasitic fungus on Juniper. A small pubescent pale species, easily known by the fuscous narrow curved band behind the middle of the elytra; the beak is punctured and striate as far as the middle, front channeled, prothorax densely not coarsely punctured;

Digitized by Google

elytra with impressed punctured striæ, interspaces nearly flat, shining, sparsely punctulate. Thighs with a very small tooth, front tibiæ straight, scarcely sinuate on the inner margin.

12. **A. sycophanta** Walsh, Proc. Ent. Soc. Phila., vi, 265.

Western States, Illinois; Mr. Walsh. Breeds in galls on willow trees. This species is easily known by the interspaces of the elytra rather flat, and nearly opaque; the punctures of the prothorax are very coarse and crowded. The pubescence is hairy above, but coarser and almost scale-like beneath, the beak is punctured and striate; the thighs are all armed with a tooth, and the front tibiæ are nearly straight. The color varies, but the elytra are always red, though sometimes darker near the scutellum.

I am disposed to believe this is *A. hæmatopus* Boh. Sch. Curc., vii, 2, 222, with the description of which it agrees in all particulars, except that the prothorax is not "*rugoso granulato,*" a style of sculpture very unlikely to occur in the genus, but which may be a vague method of indicating the very coarse deep punctures with narrow high intervals which characterize this species.

13. **A. rufipennis**, n. sp.

Oblong, blackish, thinly but finely pubescent with white hair. Beak striate and punctured, head sparsely punctulate, front foveate; prothorax a little longer than wide, narrowed in front and broadly rounded on the sides, feebly constricted as usual, surface densely and coarsely punctured, though less so than in the preceding species; elytra oblong, humeri less prominent than usual, and rather oblique, striæ well impressed, coarsely punctured, interspaces slightly convex, shining, sparsely punctulate, ferruginous, suture darker, scutellum clothed with white hairs. Antennæ and legs ferruginous, thighs strongly toothed, front tibiæ straight, slightly sinuate on inner side. Length 2.2 mm., .09 inch.

One specimen, Pennsylvania. Of the same form and size as the preceding, but easily known by the less coarse punctures of the prothorax, and the smoother and shining elytral interspaces; the humeri are less prominent than in our other species.

14. **A. suturalis** Lec., Ann. Lyc. Nat. Hist. N. York, i, 171, pl. xi, f. 9; Gyll., Sch. Curc. iii, 346; Boh., ibid. vii, 2, 223 (cum var.); *A. erythropterus* Say, Curc. 25; ed. Lec. i, 293.

Middle, Southern, and Western States. Varies in color and extent of the red elytral spot, which is sometimes bright yellowish-red, and distinctly limited, sometimes dark and diffused, so that only the suture remains blackish. In one specimen the surface of the elytra is dull and finely rugose, but I suspect that this has been caused by some injury received in the early stages of development, and must be regarded as an accidental monstrosity, and not as a variation.

15. **A. musculus** Say, Curc. 15; ed. Lec. i, 277; Gyll. Sch. Curc. iii, 350.

Middle, Southern, and Western States. Closely allied to the varieties of

Digitized by Google

the preceding in which the red is diffused over the elytra; but smaller and more robust, with the beak more slender, and the funicle of the antennæ with the outer joints more rounded; I can find no other differences worth mentioning, and it will very probably be found to be not distinct.

16. **A. sulcifrons**, n. sp.

Black, with rather dull lustre, thinly pubescent above, more densely beneath. Beak strongly punctured, striate at base, head sparsely punctulate, with a deeply marked frontal stria. Prothorax wider than long, gradually narrowed from the base, feebly rounded on the sides, deeply and densely punctured. Elytra one-third wider than the prothorax, slightly ovate, striæ deep, coarsely punctured, interspaces convex, nearly smooth; behind the middle are two series of small spots of pubescence, as in well preserved specimens of the preceding three species. Antennæ piceo-testaceous; thighs scarcely clavate, with a very small tooth scarcely visible on the middle and hind pair. Length 1.6 mm.; .065 inch.

One specimen, Georgia. Also related to the two preceding, but readily known by the entirely black color, and sulcate front.

17. **A. flavicornis** Boh., Sch. Curc. vii, 2, 231.

Maryland to Texas. The beak is sparsely punctured, finely striate, head nearly smooth, front channeled, prothorax moderately densely punctured, and elytral striæ fine, distant, and finely punctured. The pubescence is white, coarse, and thinly distributed, a little more dense beneath. The antennæ are yellow-testaceous, and the tarsi piceous. All the thighs armed with a small acute tooth. The scutellum and a small intra-humeral spot are densely pubescent.

18. **A. morulus**, n. sp.

California, San Mateo and Gilroy; Mr. Crotch.

A small black species of the same size and general form (2.2 mm.; .09 inch), as the preceding, but with the beak longer and more punctured, the head distinctly punctured, the frontal stria shorter. The prothorax is equally strongly punctured, but more rounded on the sides. The elytral striæ are well impressed, strongly and closely punctured, and the interspaces flat and rugose. The pubescence is very fine and sparse, a little more distinct beneath. The antennæ are dark-testaceous with the club piceous; the thighs are scarcely clavate, and hardly perceptibly toothed.

19. **A. nigrinus** Boh., Sch. Curc. vii, 2, 230.

Georgia and Louisiana; three specimens. Of the same size and general form, and as finely pubescent as the last species. The prothorax is very coarsely punctured, and the elytral striæ are less impressed, but more coarsely punctured, and the interspaces less flat, and nearly smooth. The antennæ are nearly black, the thighs are armed with a very minute tooth, more distinct on the front pair.

20. **A. corvulus**, n. sp.

Black, slightly pruinose with sparse white pubescence. Beak punctured and feebly striate, head opaque, with a small frontal fovea. Prothorax

Digitized by Google

closely but less coarsely punctured than in the preceding, wider than long, narrowed in front and feebly rounded on the sides. Elytra sub-ovate, striæ strongly punctured, not much impressed, interspaces shining nearly smooth. Antennæ piceous, base testaceous; thighs slightly clavate, armed with a very small tooth. Length 1.5–2 mm.; .06-.08 inch.

Atlantic slope, extending to Oregon. Easily known by the small size, and which at first sight causes it to resemble an apion.

21. **A. pusillus**, n. sp.

Testaceous, thinly sprinkled with white scale-like hairs. Beak long and slender, sparsely and finely punctured, head with a small frontal puncture. Prothorax wider than long, rounded on the sides, coarsely and deeply punctured. Elytra sub-ovate, less elongate than usual, striæ coarsely punctured, interspaces nearly smooth, slightly convex. Legs rather stout, thighs acutely toothed. Length 1.4 mm.; .05 inch.

One specimen, Texas; Belfrage. A robust species easily known by the small size and the characters above given.

22. **A. elegans**, n. sp.

Rather broadly ovate, brown, clothed with very small depressed scales of a brown and gray color, with the scutellum and neighboring elytral spot snow white. Beak slender, straight, as long as the head and prothorax, shining, punctured, striate for two-thirds the length; head punctured, front narrow, channeled; eyes larger and more prominent than usual. Prothorax as wide as long, gradually narrowed and slightly rounded on the sides from the base, densely punctured, marked with a narrow transverse and longitudinal line of white scales forming a cross; at the middle of the base some scattered white scales; near the apex two spots of silky yellow-brown scales, and a similar larger spot on the inflexed sides. Elytra wider than the prothorax, nearly truncate at base, humeri prominent rounded; striæ punctured, obscured by the scales which form a beautiful complex pattern of brown, dark-brown, and gray. Beneath mottled with gray scales, legs stout, thighs thick and strongly toothed, tibiæ with an obtuse angle on the inner side at one-third the length; claws cleft as usual. Antennæ testaceous brown, funicle slender with the first joint long, second a little longer than the third; club almost articulated. Length 2 mm.; .08 inch.

Two males, Haulover, Florida, March 10th; Schwarz and Hubbard. The pygidium is perpendicular, and even slightly inflexed. The large convex eyes, the narrow front, and tibiæ armed with a tooth on the inner side, easily distinguish this beautiful species. The prosternum is extremely short, more so, in fact, than in any other species known to me.

23. **A. squamosus**, n. sp.

Brown, densely clothed with scale-like gray pubescence; beak naked, red-brown, shining, finely punctured, not striate, frontal fovea elongate; prothorax broader than long, narrowed in front, rounded on the sides, densely punctured. Elytra suddenly one-third wider than the prothorax,

Digitized by Google

not elongate, striæ impressed, punctured, interspaces quite flat. Antennæ ferruginous, slender, second joint of funiculus longer than third; legs ferruginous, thighs clavate, armed with an acute tooth. Length 4.4 mm.; .17 inch.

Colorado; not rare. In some specimens three thoracic vittæ and the alternate interspaces of the elytra are paler; the scutellum is nearly white.

24. **A. tectus**, n. sp.

Blackish, less densely clothed with yellowish or whitish scales, beak slightly pubescent, coarsely punctured and striate, frontal fovea elongate. Prothorax wider than long, narrowed in front, broadly rounded on the sides, densely punctured. Elytra wider than the prothorax at base, striæ coarsely punctured, interspaces flat, fourth covered with paler scales from the base to behind the middle; sixth from the base nearly to the middle. Antennæ brown, scape and base of funiculus ferruginous; second joint of funiculus scarcely longer than third. Legs ferruginous, thighs armed with a small acute spine. Length 2.4 mm.; .10 inch.

Massachusetts; Georgia.

25. **A. hirtus**, n. sp.

Elongate, black, densely clothed with coarse scarcely squamiform ochreous pubescence. Beak slightly pubescent, punctured obsoletely striate at base. Prothorax not wider than long, gradually narrowed in front, broadly rounded on the sides, densely punctured. Elytra elongate oblong, wider than the prothorax at base, striæ punctured, interspaces flat, antennæ and legs ferruginous, club and thighs darker, the latter clavate armed with a scarcely perceptible tooth; second joint of funicles scarcely longer than third. Length 3.2 mm.; .13 inch.

One specimen, Utah.

26. **A. inermis** Boh., Eugenies Resa, Coleopt. 131.

Elongate, ferruginous, very densely clothed with large whitish scales, beak naked except at base; punctured, and feebly striate. Prothorax densely and deeply punctured.a little wider than long, narrowed in front and rounded on the sides. Elytra a little wider than the prothorax at base, elongate oblong, striæ strongly punctured, interspaces moderately convex, nearly smooth, club of antennæ darker, second joint of funicle scarcely longer than third; thighs feebly clavate, not toothed. Length 2.2 mm.; .09 inch.

Mariposa, California; Dr. Thevenet.

27. **A. subvittatus**, n. sp.

Of the same form as the preceding, but a little larger, and darker in color; the scales are smaller, though equally dense; the prothorax has three white vittæ, with two intermediate brownish ones; the elytra are mingled brown and white, with a posterior stripe on the third interspace, and one on the fifth extending from the base to the middle pale; the scutellum as usual is pale. The front thighs are almost imperceptibly toothed. Length 2.5 mm.; .10 inch.

San Diego and Mariposa, California; five specimens.

Digitized by Google

28. **A. pauperculus**, n. sp.

Also of the same form as *A. inermis* and densely covered with broad scales of dirty white, mixed with pale brown; other characters as in that species, except that the front thighs are armed beneath with a distinct, though not very prominent tooth. Length 2 mm.; .08 inch.

San Diego, Cala.; five specimens.

29. **A. disjunctus**. n. sp.

Subovate, brown, covered beneath with pale, above with brown scales; beak long, punctured and striate, head feebly punctured, frontal fovea elongate. Prothorax wider than long, gradually narrowed in front from the base, slightly rounded on the sides, deeply and densely punctured, with three dorsal vittæ of pale scales. Elytra at base not wider than the prothorax, gradually wider and slightly rounded on the sides, striæ punctured, interspaces slightly convex, fourth for the middle, third and sixth from base to middle covered with pale scales. Antennæ testaceous at base, second joint of funiculus as long as the two following. Thighs clavate, armed with a small tooth, which seems to be wanting on the hind pair. Length 3.2 mm.; .125.

Georgia and Illinois; two specimens. The outer interspaces of the elytra behind the middle, and the scutellum are also covered with pale scales. The teeth of the tarsal claws are more approximate than in any of the preceding species, and seem to be almost connate.

30. **A. rufipes**, n. sp.

Subovate piceous, less densely clothed with white scales, beak long, punctured and striate, head punctured, frontal fovea small. Prothorax as in the preceding. Elytra not wider at base than the prothorax, gradually wider and slightly rounded on the sides; striæ strongly punctured, interspaces flat, antennæ and legs ferruginous, second joint of funiculus hardly longer than the third, thighs clavate, armed with an acute tooth, which is smaller on the hind pair but quite distinct. Length 2.6 mm.; .10 inch.

New York, one specimen.

31. **A. elongatus**, n. sp.

Elongate, dark brown, partly clothed with small gray scales, forming an indistinct pattern on the elytra. Beak longer than the head and prothorax, slender, cylindrical, curved, densely punctured, and finely carinate; head punctured, vertex channeled, front scarcely as wide as usual. Prothorax strongly and densely punctured, wider than long, nearly truncate at base, gradually narrowed from the base and slightly rounded on the sides; white scales more dense each side at the base, forming an ill-defined spot. Elytra a little wider than the base of the prothorax, elongate, oval; striæ fine, punctured; interspaces not convex, finely alutaceous. Thighs feebly clavate, not toothed; front and middle tibiæ slightly sinuate; claws cleft as usual. Antennæ testaceous, club dusky; first joint of funicle as long as the second and third united. Length 2.3 mm.; .09 inch.

Georgia; two specimens. Resembles in form certain species of *Smicro-*

Digitized by Google

nyx. In this species as in *A. inermis, subvittatus*, and *pauperculus*, the pygidium is entirely covered by the elytra, and the fifth ventral is longer than in the other species. In a revision of this group they may indicate a distinct genus.

Division C. Funiculus of antennæ 6-jointed.

32. **A. crataegi** Walsh, Proc. Ent. Soc. Phila. vi, 266.

Middle, Western, and Southern States, to Texas.

An elongate uniformly ferruginous species, with dull lustre, and pubescent with yellowish hairs, which are condensed on the median line of the prothorax forming a dorsal vitta. The beak is punctured, and the front channeled; the prothorax densely punctured; the elytra deeply striate, with the interspaces convex. The funiculus of the antennæ is 6-jointed, and slender, second joint a little longer than third; thighs armed with an acute tooth; front tibiæ nearly straight. The size and form is as in *A. sycophanta*, and like that species, it is parasitic in galls; in this instance, however, upon *Crataegus*, and in the other upon *Salix*. Length 2.3 mm.; .09 inch.

33. **A. subfasciatus**, n. sp.

Reddish-brown, rather robust, finely and thinly pubescent; beak opaque, not distinctly punctured; prothorax strongly punctured, elytra with the striæ coarsely punctured, interspaces nearly smooth; behind the middle is a broad transverse denuded band, at the margins of which the pubescence is more condensed. Antennæ more robust than in the preceding, funiculus 6-jointed, second joint not longer than the third. Thighs with a small acute tooth. Length 1.5 mm.; .06 inch.

One specimen, New York. Greatly resembles what I have above considered as *A. musculus*, but is much smaller, and differs by the 6-jointed funiculus of the antennæ.

34. **A. robustulus**, n. sp.

Robust, black, clothed with ashy scales. Beak punctured and feebly striate. Prothorax much wider than long, narrowed in front, rounded on the sides, closely and deeply punctured. Elytra one-third wider than the prothorax, striæ coarsely punctured towards the base, interspaces flat. Antennæ and feet brown, thighs not toothed, funiculus 6-jointed, second and third joints equal, or nearly so. Length 1.5 mm.; .06 inch.

Kansas; three specimens.

35. **A. nubilus**, n. sp.

Rusty brown, rather elongate, sparsely and finely pubescent, with intermixed scattered pale-yellowish scales. Beak finely punctured, obsoletely striate, frontal fovea feeble. Prothorax wider than long, narrowed in front and rounded on the sides, strongly punctured, with a short whitish dorsal line behind the middle. Elytra with the striæ very coarsely punctured, interspaces slightly rugose; the scales are irregularly scattered, so as to give the appearance of a large denuded dorsal space, and a posterior denuded band oblique inwards and backwards. Antennæ with the funiculus stout,

Digitized by Google

6-jointed, second joint not elongated, club fuscous, of the usual form. Legs rather stout, thighs not toothed; claws very feebly toothed at base. Length 1.6 mm.; .07 inch.

One specimen, North Carolina; Dr. Zimmerman. The nearly simple ungues distinguish this readily from all other species in our fauna, except the next, and might lead, on superficial view to its being placed in the *Erirhini* tribe, from which it essentially differs by the antennal club, and by the ventral segments being nearly equal in length.

36. **A. ungularis**, n. sp.

Elongate, dark brown, thinly clothed with pubescence, and with a faint appearance of a transverse denuded band behind the middle of the elytra. Beak indistinctly punctured, obsoletely striate, head opaque, frontal fovea small, distinct. Prothorax wider than long, rounded on the sides, narrowed in front of the middle, densely punctured Elytra one-fourth wider than the prothorax, oblong, striæ coarsely punctured, interspaces nearly smooth; pubescence more dense on the scutellum, a small humeral spot, and two very indistinct posterior narrow bands, which tend to unite at the suture. Sides of meso- and metathorax densely pubescent. Antennæ and legs ferruginous, funiculus 6-jointed, second joint elongate; thighs not toothed, claws with a short acute basal tooth, slightly connected at base. Length 2.3 mm.; .09 inch.

Southern States; Dr. Zimmermann.

37. **A. mixtus**, n. sp.

Elongate-ovate, yellow-brown; pubescence white, coarse, scattered, condensed on the elytra, into several indefinite bands; beak punctured and strongly striate. Prothorax smaller than usual, wider than long, gradually narrowed in front, slightly rounded on the sides, coarsely punctured. Scutellum white-pubescent. Elytra at base but little wider than the prothorax, gradually wider, elongate-ovate, brown, with the humeri and a common sutural rounded spot behind the middle, yellow-brown; two narrow indistinct transverse bands of pubescence before the middle, and others behind the middle; striæ strongly punctured, interspaces slightly convex, nearly smooth. Antennæ with funiculus 6-jointed, second and third joints equal; thighs scarcely clavate, acutely toothed; claws divergent, armed with a short basal tooth, which is rounded at tip. Length 2.3–3 mm.; .09–.12 inch.

Illinois, Walsh; Texas, Belfrage. On account of the comparatively smaller size of the prothorax, this insect has some resemblance in form to *Orchestes*, but the eyes are of the usual size in the present genus, widely separated, and the hind legs are not thicker. The elytra are not rounded on the sides behind the humeri, though gradually wider as far as the middle.

38. **A. decipiens**, n. sp.

Rather elongate, brown, densely clothed with large gray scales; prothorax indistinctly striped; elytra with a darker lateral cloud behind the mid-

Digitized by Google

dle. Beak slender, curved, longer than the head and prothorax, naked, punctured, substriate near the base; head punctured, clothed with fine scales. Prothorax one-third wider than long, narrowed from the base, rounded on the sides, densely punctured. Elytra a little wider than the prothorax; sides parallel, then obliquely narrowed and rounded to the tips, which entirely cover the pygidium; striæ strongly punctured, interspaces nearly flat. Legs testaceous, front thighs toothed, hind thighs not toothed; claws toothed, with the teeth nearly connate; antennæ testaceous, funicle 6-jointed, first joint elongate, second joint nearly as long, but thinner. Length 2 mm.; .08 inch.

Texas, Belfrage; one specimen. Has quite the appearance of a *Smicronyx*. The last ventral segment is a little longer than the fourth, and is marked with a large shallow rounded impression. There are some white markings upon the elytra of which a narrow scutellar spot and a line upon the sixth interspace from the base to the middle are most obvious.

39. **A. canus**, n. sp.

Elongate, brown, or blackish-brown, densely clothed with large grayish-white scales; in every respect like the preceding, except that the scales are entirely uniform in color. Length 2 mm.; .08 inch.

Texas, Belfrage; four specimens. The pygidium of the ♂ is convex perpendicular, and indeed, slightly inflexed; the fifth ventral is a little longer than the fourth, and not impressed in either sex; the pygidium of the ♀ is but slightly visible between the tips of the elytra.

40. **A. affinis**, n. sp.

This species also resembles in form and sculpture the preceding two species. The color is nearly black, clothed with pale gray scales of uniform color. The legs and antennæ testaceous, front thighs toothed, hind thighs simple; claws toothed as in the preceding. Antennæ with 6-jointed funicle, second joint shorter than first, and equal to the third. Length 2 mm.; .08 inch.

Texas, Belfrage; three females. The pygidium in two specimens is barely visible, and in the third is completely covered by the elytra.

41. **A. nanus**, n. sp.

Also similar to the three preceding species but much smaller and narrower, nearly black, clothed with large gray scales. Prothorax very little wider than long, less narrowed in front, less rounded on the sides. Elytra very little wider than the prothorax. Antennæ brown, funicle 6-jointed, with the second joint equal to the third, and united equal to the first. Legs brown, thighs not toothed. Length 1.5 mm.; .06 inch.

Texas, Belfrage; two specimens. The pygidium is slightly exposed, and in the ♀ the last ventral is impressed with a shallow round fovea. The claws are toothed as in the three preceding species.

ORCHESTES Illiger.

This genus is closely allied to *Anthonomus*, and like it has the ventral sutures straight and deeply marked, and the last segment not longer than

Digitized by Google

the preceding. It differs by the eyes being large, approximate above, so as to narrow the front, and by the hind thighs being thickened, so as to become saltatorial. The claws are appendiculate in our species.

As in *Anthonomus*, the funicle of the antennæ is 6-jointed in some, 7-jointed in other species.

An excellent analytical table with full descriptions of our species, of which but four were known, has been published by Dr. Horn, in Proc. Amer. Phil. Soc. Nov. 1873, p. 461. To the species described by him must be added the following:

1. **O. rufipes**, n. sp.

Black, very thinly pubescent, with fine whitish hairs; beak finely punctured, head punctured, front narrow, but distinct; prothorax finely punctured; elytra oval, rather flattened, deeply striate, interspaces rugosely punctulate. Antennæ and legs yellow, hind thighs dusky, very slightly incrassated; funicle 6-jointed, second joint scarcely longer than the third; thighs not toothed; claws broadly appendiculate. Length 2 mm.; .08 inch.

Vermont; two specimens. Smaller than *O. pallicornis*, with the eyes less approximate, the hind thighs scarcely thickened, and the legs not black, but ferruginous-yellow.

2. **O. puberulus** Boh., Eugen. Resa. Ins., 133.

California, one specimen. Larger than the other species; black, rather densely clothed with coarse brown pubescence. Prothorax at base twice as wide as the head, not wider than long, narrowed from the base to the tip, punctured. Elytra elongate-oval, nearly twice as wide as the prothorax; humeri regularly rounded, not prominent; striæ composed of rather large, deep but not very close punctures. Antennæ testaceous, funicle 6-jointed, joints 1–3 elongate; legs testaceous, thighs not toothed; claws broadly appendiculate. Length 3.3 mm.; .13 inch.

3. **O. parvicollis**, n. sp.

Black, thinly clothed with very fine pubescence, which is not very obvious, except upon the scutellum. Prothorax at base a little wider than long, narrowed in front, sides nearly straight; surface densely and strongly punctured. Elytra elongate-oval, more than one-half wider than the prothorax; striæ deep, punctured, interspaces finely rugose. Antennæ and legs black; funicle 7-jointed; thighs not toothed; claws broadly appendiculate. Length 2.8 mm.; .11 inch.

San Mateo, California; one specimen. Resembles *O. niger*, Horn, but is larger, with the scutellum less densely pubescent; the prothorax less coarsely punctured, and the elytra comparatively longer and more regularly oval.

MACRORHOPTUS Lec.

This new genus is established upon a species from Texas and California, having the aspect somewhat of a small *Magdalis*, but with the hind angles of the prothorax not laminate, and of the usual obtuse form. It is remarkable for the short thick 6-jointed funiculus, the joints 2–6 being

Digitized by Google

closely connected, gradually wider, and uniting with the annulated club so as to form a regular club shaped outline. The beak is cylindrical, rather stout, about as long as the prothorax; antennæ inserted one-fourth from the end; eyes large, transversely oval; front narrower than the beak. Prothorax wider than long, narrowed in front, broadly rounded on the sides; prosternum short, emarginate in front. Elytra elongate, wider than prothorax; humeral angles rounded, sides parallel, striæ obsolete. Ventral segments nearly equal, third and fourth very little shorter, sutures straight, less deeply impressed than in *Anthonomus*. Legs rather short, front thighs armed with a large tooth, other thighs unarmed, sub-clavate; tibiæ straight, obliquely truncate, without terminal hook; claws with a slender tooth, as in most *Anthonomus*.

1. **M. estriatus**, n. sp.

Elongate, black, not very densely covered with elongate cinereous scales; beak densely finely punctured, separated from the front by a feeble transverse impression; head punctured; prothorax more deeply and coarsely punctured; elytra densely punctured, with slight traces of striæ near the margin and tip; front thighs strongly toothed; antennæ brown, with verticellate rows of white scales. Length 2.7 mm.; .10 inch.

Texas, Belfrage; Santa Barbara and Warner's Ranch, California, Crotch.

When the scales are rubbed off a fine inconspicuous pubescence remains. The emargination of the prosternum gives an appearance of feeble postocular lobes, and in following Lacordaire's arrangement this genus would be placed in the *Ceratopides*, after *Acanthobrachium*, from which it seems to differ by having only the front thighs toothed.

ALYCA n. g.

I have separated as a distinct genus *Erirhinus ephippiatus* Say, which differs from the other genera of this group by having the last ventral segment as long as the two preceding, and the claws divergent and broadly appendiculate. The beak is not very slender, cylindrical, as long as the prothorax; the antennæ are inserted about one fourth from the end; the scape attains the eyes, which are rounded, moderate in size, and distant; funiculus 7-jointed, first joint stouter and longer, the others equal, gradually a little wider, the outer ones rounded; club elongate-oval, annulated. Prothorax wider than long, narrowed in front of the middle, rounded on the sides, feebly constricted near the tip. Elytra wider than prothorax, oblong-elongate, humeri rounded, sides parallel, striæ punctured, interspaces nearly flat. Prosternum short in front of the coxæ. Ventral sutures straight, third and fourth segments united equal to each of the others, fifth flat, with a very small apical carina in one sex. Legs moderate, thighs feebly clavate, not toothed, tibiæ with a distinct terminal hook, tarsi dilated, third joint very broad, bilobed; claws divergent, with a broad rectangular tooth or appendiculum.

1. **A. ephippiata.** *Erirhinus ephipp.*, Say, Curc. 25; ed. Lec. i, 293; Gyll. Sch. Curc. iii, 289; Walsh, Proc. Ent. Soc. Phil. vi, 268.

Digitized by Google

Atlantic slope; found also by Mr. Crotch at San Diego and San Bernardino, California.

A small yellowish-brown insect, densely clothed with yellow pubescence, with a large dark spot near the base and another transverse one behind the middle, connected by a sutural stripe; sometimes there is an appearance of a third spot near the tip of the elytra.

This insect might be easily confounded with some of the varieties of *Phyllotrox nubifer*, but the elytra are less broadly rounded at tip, and the claws are not simple, but broadly appendiculate. It varies greatly in size, 1.8–2.9 mm.; .07–.11 inch. Bred by Mr. Walsh from a *Cecidomyidous* gall; *S. brassicoides* of *Salix longifolia*.

Tribe X. PRIONOMERINI.

This tribe contains a few small species of robust form, easily known by the following assemblage of characters:

Beak stout, sometimes short and flat: antennæ inserted about the middle, scape extending upon the eyes which are large and rounded; funicle 7-jointed, club very large, pubescent, oval pointed, almost articulated. Prothorax without postocular lobes, front coxæ contiguous; prosternum short, not emarginate.

Ventral sutures deeply impressed; the first is straight, the others strongly angulated at the sides; fifth segment scarcely longer than the fourth. Legs stout, tibiæ with a slender terminal hook; tarsi dilated, spongy beneath; third joint bilobed, claws appendiculate. Pygidium more or less visible.

Beak as long as prothorax. sub-cylindrical; long; front thighs with a large serrated tooth .... **Prionomerus.**
Beak short, broad and flat; thighs with a small acute tooth...... .... **Piazorhinus.**

PRIONOMERUS Sch.

1. **P. calceatus.** *Anthonomus* (*Odontopus* †) *calc.* Say, Curc. 15; ed. Lec. i, 278; *Prion. carbonarius* Gyll., Sch. Curc. iii, 360.

Atlantic States. I do not know why Gyllenhal has suppressed the specific name proposed by Say, in favor of one taken from Dejean's Catalogue. It is unfortunate that the generic name given by Say was not accompanied with a proper description, as it would then (1831) have had precedence over the homonyms of Silbermann in *Coleoptera*, and Laporte in *Hemiptera*.

PIAZORHINUS Sch.

1. **P. scutellaris** Gyll., Sch. Curc. iii, 472; *Attelabus scut.* Say, Journ. Ac. Nat. Sc. Phil. v, 252; ed. Lec. ii, 315.

Atlantic States. The antennæ are scarcely geniculate, and being inserted nearer the eyes in consequence of the shortness of the beak, the scape is less elongated than in the preceding genus. I observe in my specimens that the thighs are armed with a small but acute tooth about the

Digitized by Google

middle on the under side; this tooth has been overlooked by Schönherr, while Lacordaire describes the thighs as unarmed.

2. **P. pictus**, n. sp.

Testaceous, clothed with pale-yellowish pubescence; head and beak dusky. Elytra with a large rounded common dusky spot extending from the base to the middle, paler within; and a dusky oblique band, more or less interrupted on the seventh interspace, which attains the suture about one-fourth from the tip; striæ punctured, less deep than in *P. scutellaris*. Thighs armed with a small acute tooth; claws appendiculate. Length 2.5 mm.; .10 inch.

Georgia; one specimen. The large common spot of the elytra is dark only at the edge, in the middle it is nearly as pale as the ground color. A manuscript drawing by my father named *Arhynchus tomentosus* Dej. Cat. resembles this species.

Tribe XI. TYCHIINI.

In this tribe a form of body is resumed, which resembles that of the *Erirhinini*. The claws, however, are not simple, but appendiculate or toothed, and the second, third and fourth ventral sutures are not straight, but strongly angulated at the sides. The prolongation backwards of the side angles of the second segment is in some genera carried to such an extent that the points reach the fourth segment, and the sides of the third segment are thus entirely covered. The pygidium is usually exposed, by the tips of the elytra being separately rounded, but in *Tychius* they are conjointly rounded, and the pygidium is covered. This character, as in *Anthonomini*, possesses, therefore, but little value. The ventral segments are less unequal than in *Erirhinini*.

The other characters are those common to the preceding tribes; Beak long and usually slender; antennæ inserted far from the tip; antennal grooves directed sometimes against the eyes, sometimes below them. The eyes are rounded or nearly so, not finely granulated. The funicle of the antennæ is 6- or 7-jointed, and the club entirely pubescent and annulated. The prothorax has no postocular lobes; the prosternum is short, not strongly emarginate in front, and the coxæ are contiguous. The side pieces of the mesothorax are diagonally divided, and the epimera do not largely attain the base of the prothorax. The metasternum is long, and the side pieces are narrow, or moderately wide, dilated in front. Tibiæ feebly or strongly mucronate; articular surface prolonged on the outer face, so as to become oblique.

Our genera with three exceptions have not been described:

Angles of second ventral segment not extending to the fourth......	2.
Angles of second ventral segment extending to the fourth..........	5.
2. Claws broadly appendiculate..	3.
" toothed..	4.

Digitized by Google

3. Beak stout; venter of ♂ with acute processes	PROCTORUS.
" slender; " " unarmed.................	ENCALUS.
4. Beak slender; fourth ventral suture indistinct	THYSANOCNEMIS.
" stout carinate....................................	PLOCETES.
5. Elytra not tuberculate................................	6.
" tuberculate....................................	TYLOPTERUS.
6. Tips of elytra conjointly rounded................	TYCHIUS.
" " separately "	7.
7. Claws toothed..............	SIBYNES.
" simplex...	PARAGOGES.

PROCTORUS n. g.

This new genus is established upon a small insect which has altogether the form, sculpture, and mottled pubescence of *Erirhinus;* it is, however, easily known by the stouter beak, the curved ventral sutures, and the broadly appendiculate claws. The sexual characters of the ♂ are very remarkable; the fifth ventral, namely, is as long as the three preceding united; it is divided by a transverse sharply elevated ridge into two parts, of which the anterior is the larger and broadly concave; the hinder part is much more deeply concave, and on each side at the junction of the elevated ridge with the margin is a stout, flattened horn, rounded at the tip; on the anterior margin of the segment, at the middle, is a third shorter horn.

Beak as long as the prothorax, rather stout, cylindrical, somewhat curved, densely punctured, not striate nor carinate. Antennæ inserted about one-fourth from the tip (♀) or less (♂); scape slender, reaching the eyes, which are rounded and distant; funicle 7-jointed; first joint as long as the two following, and stouter; 2–7 short, equal, gradually a little wider; club moderate in size, elongate-oval, subacute, annulated; antennal grooves reaching the lower margin of the eyes. Prothorax about as wide as long, rounded on the sides in front, and feebly impressed near the tip. Elytra wider at base than prothorax, elongate oblong, humeri prominent, rounded, sides parallel; marginal stria incomplete at the middle. Ventral segments unequal; third and fourth together scarcely longer than each of the others; first suture straight at the sides, arched forwards at the middle; other sutures angulated at the sides. Legs rather short, thighs not toothed; tibiæ straight, the front pair with a small terminal hook; tarsi with the first joint slightly longer than the second, third broader bilobed; last joint as long as the first and second; claws divergent, broadly dilated and appendiculate at base.

1. **P. armatus** n. sp.

Black, thinly clothed with white hairy pubescence, which is somewhat mottled upon the elytra. Beak densely punctured. Prothorax closely and deeply punctured. Elytra with striæ strongly punctured, interspaces nearly flat, sparsely punctulate. Antennæ piceous. Length 3.4 mm.; .13 inch.

South side of Lake Superior; three specimens.

Digitized by Google

ENCALUS n. g.

This genus also resembles a small *Erirhinus*, and differs from *Proctorus* only by the beak being longer than the prothorax, and more slender; it is also punctured and feebly striate towards the base, as in many *Anthonomi*. The antennæ are inserted about one-fourth from the end of the beak; the scape almost reaches to the eyes, which are moderate in size and distant; the funiculus is 7-jointed, first joint longer, the others nearly equal, short, gradually wider and more rounded; club oval, annulated; ventral segments unequal, third and fourth together as long as second, fifth nearly as long; first suture straight; others angulated at the sides. Legs moderate, thighs armed with a small tooth; claws divergent, broadly appendiculate.

1. **E. decipiens** n. sp.

Black, clothed with white and yellowish pubescence. Prothorax not wider than long, broadly rounded on the sides, coarsely and very deeply punctured. Elytra wider than prothorax, at base elongate oblong, with a broad transverse black band occupying the middle third; striæ coarsely punctured, interspaces flat. Antennæ and legs piceo-ferruginous. Length 3.4 mm.; .13 inch.

Illinois and Minnesota; two specimens. In form and color this insect bears an almost deceptive resemblance to *Macrops solutus*, but in other characters it is in every way different.

PLOCETES n. g.

Beak rather stout, as long as the prothorax, carinate, punctured and with three fine elevated lines each side; antennal grooves deep, extending to the lower margin of the eyes, which are oval and rather large. Antennæ inserted about one-fourth from the tip, scape reaching nearly to the eyes; funicle 7-jointed, first joint as long as the three following united and stouter; second a little longer than third; 3–7 equal, scarcely increasing in width; club elongate-oval, annulated, rather large. Prothorax scarcely wider than long, rounded on the sides, narrowed in front of the middle, neither lobed nor constricted in front. Elytra one-half wider than prothorax, humeri oblique and rounded, disc not very convex, posterior callus rather prominent. Abdomen rather flattened; first ventral suture straight; the others distinctly angulated near the sides; third and fourth segments very little shorter than the first and second; fifth about one-half longer than fourth; pygidium covered. Legs rather stout, thighs clavate, with a very small tooth beneath, tibiæ broadly sinuate on the inner side; terminal hook distinct; tarsi with third joint bilobed, claws with a long, slender tooth, not bent inwards.

1. **P. ulmi** n. sp.

Black, clothed with small brown scaly hairs; beak carinate, striate and punctured, head punctured. Prothorax densely and deeply punctured, with a smooth, slightly elevated dorsal line. Elytra with a transverse band behind the middle, of white pubescence, which is longer and more dense near

Digitized by Google

the suture; scutellum white; striæ composed of quadrate punctures, interspaces flat, densely rugose. Antennæ and legs dark reddish brown. Length 4 mm.; .15 inch.

Middle, Southern and Western States; Mr. C. V. Riley has given me a specimen, with the following note of habits: "On elm; makes a similar noise to the Plum Curculio, August 5th, 1874." Behind the white band the suture is velvety black, contrasting well with the diffused brown tint into which the band fades towards the tip of the elytra.

This curious insect is suggestive of a very small *Pissodes*, with which, however, it has no relations beyond the mere superficial resemblance in form and sculpture.

THYSANOCNEMIS n. g.

A singular genus somewhat resembling *Anthonomus* in appearance, but known at once by the front tibiæ of the ♂ being broader than usual, sinuate, and densely fringed on the inner side with long hair.

Beak longer than the prothorax, slender, moderately curved, cylindrical; eyes rather large, front narrow; antennæ inserted about one-fourth from the end of the beak, scape slender, reaching the eyes; funicle 7-jointed, first joint long and thicker, second a little longer than third; 3–7 nearly equal, scarcely increasing in width; club rather large, elongate-oval, very distinctly annulated. Prothorax wider than long, narrowed in front, and feebly constricted, broadly rounded on the sides. Elytra nearly one-half wider than the prothorax at base, oblong, slightly narrower from the humeri, which are prominent and rounded. Ventral segments unequal; first and second equal; third and fourth equal, but together a little longer than the second; fifth longer than third and fourth united; first suture straight, the others angulated at the sides; fourth suture nearly obliterated at the middle; pygidium partly exposed, perpendicular. Legs stout, thighs not toothed, tibiæ of ♂ thick, sinuate on the inner side, armed with a small terminal hook; front pair also with a long dense fringe of yellow hair on the inner margin; tibiæ of ♀ more slender, claws with a long tooth, which curves inwards, as in most species of *Anthonomus*.

1. **T. fraxini** n. sp.

Ferruginous, clothed with yellow hair. Beak finely punctured, obsoletely striate. Prothorax densely punctured. Elytra with punctured striæ, and slightly convex, nearly smooth interspaces; with a broad transverse band occupying the middle third, and dilated at the margin, less densely pubescent, and of a darker color. Length 3.7 mm.; .15 inch.

One male given me by Dr. Melsheimer, as found in York County, Pennsylvania; several females collected by Mr. Pettit on ash trees in Canada.

2. **T. helvolus** n. sp.

Brown, clothed with short sericeous yellowish brown hair; beak long, slender, much curved, nearly smooth; head opaque, punctured, front pubescent, not wider than the beak; eyes rather large. Prothorax twice as wide as long, much rounded on the sides, strongly punctured, sub-carinate.

Digitized by Google

Elytra one-fourth wider than the prothorax, oblong-elongate, humeri rounded, striæ impressed, interspaces nearly flat; third and fifth a little wider. Legs yellow; thighs unarmed; antennæ yellow, long and slender, funiculus 7-jointed, first and second joints elongate; club annulated, elongate-oval. Length 3.8 mm.; 1.5 inch.

Illinois; one female.

TYLOPTERUS n. g.

This genus is established upon two small species from Texas, clothed with remarkably dense sericeous pubescence, and having small tufts of hair and very prominent elytral callus. The beak is slender and curved; the eyes large; the front narrow (about one-third as wide as the beak). The antennæ are inserted about one-fourth from the end of the beak, slender; the scape reaches the eyes; funiculus 7-jointed, first joint as long as the two following; second joint a little longer than the third; club elongate-oval, annulated. Prothorax wider than long, narrowed in front, broadly rounded on the sides, convex. Elytra suddenly more than one-third wider than the prothorax, humeri prominent, elevated, rounded, sides converging a little behind; posterior callus very prominent. Ventral segments subequal, except the fifth, which is as long as the two preceding united; first ventral suture straight, others angulated at the sides, but the second more so than the third, so that the angles of the second segment project over the third nearly to the fourth segment. Pygidium of ♀ nearly covered by the elytra; anal segment of ♂ large, deflexed, and convex. Legs rather long, thighs clavate, not armed, front tibiæ longer, more slender, and slightly sinuate in ♂; terminal hook very small; claws with a large tooth near the tip.

1. T. **pallidus**, n. sp.

Densely clothed with pale ashy hair, with golden reflexions, which conceals the sculpture; front channeled. Elytra with the posterior callus in the form of a large obtuse tubercle, causing the declivity to appear broadly concave; marked with two irregular transverse bands of brown hair, the posterior one in front of the callus, and narrowed at the suture; the front one commencing at the middle on the sides, and running obliquely backwards to the suture, where there is a narrow tuft of black hair occupying the first interspace for one seventh of its length; small pencils of black hair are also seen on the third, fifth and seventh interspaces where the bands cross them; there is also a little tuft on the third interspace near the base. Antennæ and legs ferruginous yellow. Beak naked, polished, sparsely punctured at the base. Length 4 mm.; .16 inch.

One ♀, Texas, given me by Mr. W. Jülich.

2. T. **varius**, n. sp.

Pubescence beneath white; above on head, prothorax and base of elytra brownish-yellow; dorsal line of prothorax and scutellum, and main surface of elytra pale cinereous, suture mostly yellow; two broad dark brown bands as in the preceding, but separated only by a narrow oblique cinereous line; interspaces with scattered small dots of longer white hairs; posterior callus

Digitized by Google

more obtuse, less prominent, tipped with yellow pubescence; beak and antennæ ferruginous, the former sparsely punctured. Length 3 mm.; .12 inch.

One ♂, Texas. Belfrage. Easily distinguished by the different color of the pubescence, the more obtuse elytral callus, and the absence of the black sutural spot.

TYCHIUS Sch.

The few species of this genus thus far known in our fauna have the funiculus of the antennæ 7-jointed, with the exception of *T. setosus*, which may perhaps be hereafter recognized as generically distinct; they resemble in form *Centrinus*, though the contiguous front coxæ and toothed claws will enable them to be immediately distinguished.

It is worthy of remark that the first observation concerning the anal segment of the ♂, is recorded by Mr. Brisout de Barneville.* Had the importance of this observation been recognized, and its limitations inquired into, much of the labor I have devoted to the study of the Rhynchophorous series would have been saved, and our knowledge concerning the classification of these insects would be much farther advanced.†

Our species may be thus distinguished :

Surface clothed with scales and pubescence only...	2.
" " " " " bristles..............	6.
2. Scales narrower, hair-like..............................	3.
" oval..	5.
3. Beak rather slender....................................	4.
" slender at tip, stout at base......................	1. **arator.**
4. Sides of prothorax rounded.............................	2. **lineellus.**
" " " oblique.............................	3. **sordidus.**
5. Scales small, dense, not mixed with hairs.......	4. **tectus.**
" larger, scattered, with pubescence intermixed..	5. **semisquamosus.**
6. Of usual size, elytra oblong..........................	6. **hirtellus.**
Very small, elytra oblong-oval.......................	7. **setosus.**

1. T. **arator** Gyll., Sch. Curc. iii. 414; (synom. excl.)

Two specimens, Illinois; Mr. Walsh. Say apparently confounded this species with the one described by him as *T. aratus*; and Major Gyllenhal suspecting perhaps the existence of some error has, while quoting Say in synonymy, given a different name to the insect received from that author. Although of the size (3.3 mm.; .13 inch) and form as *T. aratus*, it is quite distinct by the beak narrowed from the base to the tip, less distinctly channeled, and more densely pubescent; the covering is of fine narrow prostrate hair-like scales of a uniform pale dirt color, and the hind thighs are distinctly toothed. *T. aratus* is unknown to me, unless it be *T. tectus*.

*Tychius de France, Ann. Soc. Ent. Fr. 1862, 765.

†*Tychius amœnus* Say, belongs to *Pachytychius*, (p. 168); *T. corniculatus* Fahræus to *Smicronyx*, (p. 173.)

Digitized by Google

2. T. **lineellus**, n. sp.

Black, densely clothed with coarse cinereous hair; which is brownish upon the alternate elytral interspaces. Beak slender, not thicker at base, pubescent, and feebly striate, tip naked; eyes small, rounded, distant, moderately convex. Prothorax a little longer than wide, narrowed in front of the middle, rounded on the sides, constricted near the tip; median line cinereous, two indistinct stripes brownish. Elytra wider than prothorax, oblong-oval, humeri rounded, convex; striæ well impressed, interspaces flat, alternately clothed with pale brown hair; suture and scutellum cinereous. Thighs stout, clavate, sinuate beneath near the tip, but not toothed. Length 3.3–4 mm.; .13–.16 inch.

California, three specimens, of which two were collected by Mr. Crotch, at Santa Barbara and Los Angeles.

3. T. **sordidus**, n. sp.

Black, densely clothed with coarse, pale brown hair, broader and scale-like beneath; beak pubescent except at tip, feebly striate, front channeled. Prothorax gradually narrowed from the base, sides oblique, broadly rounded, feebly constricted at tip. Elytra oblong-oval, wider than prothorax, humeri rounded, striæ well impressed, interspaces flat; in certain directions some of the hairs have a metallic lustre. Thighs stout, clavate, sinuate beneath near the tip; hind pair obtusely but not distinctly toothed. Length 4 mm.; .16 inch.

One specimen, Illinois. Differs from the preceding chiefly by the uniform pubescence, and the less rounded sides of the prothorax.

4. T. **tectus**, n. sp. ? *T. aratus* Say, Curc. 26; ed. Lec. i, 294.

Blackish-brown, very densely covered with small, oval, closely applied brownish white scales. Beak slender, not thicker at the base, as long as the head and prothorax, slightly curved; pubescent except at tip, finely channeled for half its length; front with a fine transverse impressed line between the eyes. Prothorax wider than long, narrowed in front of the middle, much rounded on the sides, feebly constricted near the tip. Elytra a little wider than the prothorax, oblong, humeri rounded, striæ well impressed, interspaces flat. Thighs clavate, sinuate beneath, but not toothed. Length 3 mm.; .12 inch.

One specimen, Kansas. The suture and sides of the elytra and dorsal line and two vittæ of the prothorax are paler, but not conspicuously so; the scales of the under surface are broader than those of the upper surface. The teeth of the claws are more approximate than in the foregoing species. The scales of the prothorax converge backwards, as described by Say, but the beak is not transversely indented over the insertion of the antennæ, and the size is smaller.

5. T. **semisquamosus** n. sp.

Elongate, dark brown, clothed with coarse, yellowish pubescence, and large oval cinereous scales, which are dense on the under surface, on three narrow prothoracic lines extending from the middle to the base, and on the

Digitized by Google

first interspace of the elytra; elsewhere they are scattered and separate. Beak as long as the prothorax, curved, densely pubescent, narrow at tip, stouter at base. Prothorax densely punctured, as long as wide, rounded on the sides. Elytra oblong-elongate, about one-third wider than the prothorax at base, sides parallel; scutellum clothed with white scales; striæ fine, interspaces flat. Antennæ brown, funicle 7-jointed, first joint longer and stouter, 2–7 equal in length, gradually a little broader; legs brown, thighs broadly toothed. Length 2.5 mm.; .10 inch.

Fort Tejon, California, Mr. Crotch. Resembles in form the next species, but differs by the pubescence being of the usual soft kind, without admixture of stiff, erect bristles. It is also smaller, and the prothorax is not wider than long, and the thighs are broadly toothed.

6. T. **hirtellus** n. sp.

Elongate, dark brown, clothed with yellow-brown scales and pubescence; with rows of longer reclinate hairs on the elytra; scales rather small, rounded oval. Beak testaceous brown, narrow at tip, stout at base, as long as the prothorax, curved, pubescent, tip naked. Prothorax wider than long, strongly rounded on the sides, narrowed and moderately constricted at tip, clothed with scales beneath, and on the sides; dark brown with a broad lateral stripe of pale brown, and a narrower dorsal stripe of white pubescence. Elytra oblong-elongate, wider than the prothorax, sides parallel, then rounded at the tip; striæ fine, well marked, punctures obscured by the dense covering of scales. Antennæ brown, funicle 7-jointed, first joint longer and stouter; 2–7 equal, gradually a little stouter; legs brown, thighs not toothed. Length 3 mm.; .12 inch.

Texas, Belfrage; two specimens.

5. T. **setosus**, n. sp.

Very small, elongate, brown, above coarsely pubescent, beneath densely covered with large scales; beak nearly straight, slender; head scaly. Prothorax hardly wider than long, narrowed in front, sides oblique, scarcely rounded. Elytra a little wider than the prothorax, striæ well impressed, interspaces slightly convex, each with a row of pale bristles. Beak, antennæ and feet ferruginous; thighs unarmed, not sinuate beneath; funicle 6-jointed. Length 1.2 mm.; .045 inch.

Fort Yuma, California; quite different in appearance from the other species, and resembling a small *Erirhinus;* the ventral sutures and claws are, however, of this genus. This is one of the smallest Curculionides in our fauna. The last ventral segment is broadly foveate in my specimens, but this is perhaps a sexual character.

SIBYNES Germ.

I refer to this genus a small species from Lower California which differs from the others of this group by the elytra being separately rounded at tip, thereby exposing a large part of the pygidium. The funicle of the antennæ is 6-jointed; the first joint is elongate, the second a little longer than

Digitized by Google

the third, and the remaining joints are gradually a little broader; club small, oval, annulated. The claws are armed with converging teeth, and the thighs are not toothed.

1. **S. fulvus** n. sp.

Above densely clothed with fulvous scales, scutellum, and beneath cinereous; beak finely punctured, pubescent at base, narrowed towards the tip. Prothorax wider than long, much narrowed and distinctly constricted in front, bisinuate at base, with the medial angle obtusely rounded. Elytra at base not wider than the prothorax, humeri oblique, obtuse; striæ impressed, interspaces flat. Beak, antennæ and legs ferruginous.

Cape San Lucas, Lower California; Mr. Xantus.

PARAGOGES n. g.

A curious little species from California constitutes this genus. It has all the essential characters of *Tychius*, except that the pygidium is somewhat exposed, and the claws are small, simple and approximate. The beak is longer than the prothorax, cylindrical, nearly straight, and rather slender. The antennal grooves descend obliquely below the eyes, which are small, rounded, and coarsely granulated. The funicle is 6-jointed; first and second joints longer, the first being stouter; 3–6 gradually a little broader, somewhat rounded; club oval-pointed, pubescent, annulated. Prothorax as long as wide, constricted near the tip, without postocular lobes. Elytra oblong elongate, wider than the prothorax, separately rounded at tip. Angles of second ventral segment prolonged as far as the fourth segment. Legs moderate, thighs not toothed; tibiæ obliquely truncate at tip, scarcely perceptibly mucronate; tarsi spongy beneath, third joint broader, bilobed; claws small, simple, not divergent.

1. **P. maculatus** n. sp.

Blackish brown, densely clothed with brownish gray scales, head and middle of prothorax darker; the latter with a few white hairs near the base. Elytra with a large, dark spot extending from the base to the middle, and from the suture to the third stria; this spot is emarginate on the sides, and rounded behind; at one-fourth from the tip is a transverse undulated dark line extending from the fourth stria to the suture; the space between this line and the spot is clothed with nearly white scales; the striæ are obscured by the dense covering of scales. Scutellum covered with pale scales. Antennæ nearly black. Length 2 mm.; .08 inch.

California: two specimens collected at San Diego, by Mr. Crotch. This is a very pretty and easily recognized insect.

Tribe XII. CIONINI.

In this tribe the funicle of the antennæ has but five joints; the club is either articulated or annulated. The front coxæ are very large and prominent, contiguous in some of the genera, separate in others; the claws are simple, approximate, free in *Miarus*, but connate in the other genera.

Digitized by Google

The form is robust, the beak cylindrical; antennæ inserted at about two-thirds the length, the scape attains the anterior margin of the eyes, which are oval, transverse, and moderate in size, and widely separated above and below. The front coxæ are large, and the sternum is short both before and behind; the middle and hind coxæ are separated, the side pieces of the metasternum narrow, and the margin of the elytra not sinuate; the side pieces of the mesosternum do not intervene between the base of the prothorax and the elytra. The ventral segments are not very unequal in length, though the third and fourth are a little shorter; the sutures are deep and angulated in the first two genera, but only slightly curved in *Gymnetron* and *Miarus*.

The species in our fauna indicate four genera.

Pygidium covered..................................	2.
" exposed, antennal club annulated..........	3.
2. Antennal club articulated.........................	**NANOPHYES.**
" " annulated.........................	**CIONUS.**
3. Front coxæ contiguous...........................	**GYMNETRON.**
" " separate.............................	**MIARUS.**

NANOPHYES Sch.

1. **N. pallidulus** Sch., Curc. iv. 787; *Rhynchænus pall.* Grav., Zool. Syst. 203; &c.

One specimen from Louisiana agrees with the figure of this Southern European species, as given by Du Val; Gen. Col. Eur, pl. 28, f. 135. It is a small, stout insect, ferruginous, thinly and finely pubescent, with the head, beak, oblique band near the base of the elytra, and small posterior spot on each side, dark. The striæ of the elytra are deep, and the interspaces somewhat convex; thighs unarmed. Length 2 mm.; .08 inch.

CIONUS Clairville.

1. **C. scrophulariæ** Oliv., Ent. No. 83, p. 106; pl. 23, f. 314; &c. &c. Sch., Curc. iv. 723; *Curculio scroph.* Linn., Fauna Suec. 603; Syst. Nat. ii, 614; &c.

This common European species is mentioned by Say, (Curc. 21; ed. Lec. i, 287) as occurring in the United States, but without definite locality. Dr. Horn has recently received a specimen collected in Louisiana by Dr. S. V. Summers.

GYMNETRON Sch.

1. **G. teter** Sch., Curc. iv. 755; &c. *Rhynchænus teter* Fabr., Syst. El. ii, 448; *Curculio teter* Fabr., Ent. Syst. i, ii, 406; &c.

Not rare on *Verbascum thapsus* in Pennsylvania. I have compared it with European specimens, and find no difference. It is a broadly ovate black insect, covered with partially erect yellowish gray pubescence, with the prothorax densely punctured, much broader than long; elytral striæ well impressed, interspaces slightly convex, rugosely punctured; tips separately rounded; beak punctured, finely channeled. Thighs thick, strongly toothed. Length, 3.7 mm.; .15 inch.

Digitized by Google

MIARUS Sch.

1. **M. hispidulus**, n. sp.

Ovate, convex, black, with a feeble bronzed tinge, clothed with grayish erect hairs. Beak long and slender, extending beyond the middle coxæ, smooth, feebly punctured at base. Prothorax wider than long, narrowed from the base forwards, obliquely but slightly rounded on the sides, densely and finely punctured. Elytra a little wider than the prothorax, shining, striæ deep, slightly punctured, interspaces nearly flat, rugose and punctulate. Thighs not toothed; tibiæ slender, straight, not armed with a hook. Length 2 mm.; .08 inch.

Texas, Illinois, Florida and Pennsylvania.

In well preserved specimens the sides of the prothorax beneath, and the trunk are clothed with dirty white scales. This species is allied to the European *M. distinctus*, but differsby the unarmed thighs.

Tribe XIII. DERELOMINI.

A tribe which contains a few small species of oblong elongate form, glabrous, and feebly punctured, with the hind angles of the prothorax rectangular and better defined than usual. The beak is slender, long, cylindrical, and is usually projected forwards; it can, at most, be bent perpendicularly downwards in repose; the antennal grooves descend obliquely to the lower edge of the eyes, which are moderate in size, nearly round, coarsely granulated and distant from the prothorax. The antennæ, inserted one-fourth from the tip, are slender, the scape reaches the eyes; the funicle is 7-jointed; first joint stouter, and as long as the two following united; the second and the succeeding ones become slightly broader, rather closely connected and merge into the club, which is pubescent, elongate, pointed, and strongly annulated. The prothorax is quadrate for the greater part, then suddenly narrowed to the tip, which is constricted; near the tip there is a short, acute oblique lateral ridge representing a part of what is the lateral margin of the pronotum in other Coleoptera. The prosternum is very long in front of the coxæ, which are nearly contiguous in our species, though distinctly separated in the foreign genera; it is not emarginate in front, and the prosternal sutures are obliterated. The elytra are scarcely wider than the prothorax, parallel on the sides, conjointly rounded behind, so as to cover the pygidium; the surface is punctulate, and the striæ are obsolete. The middle coxæ are moderately separated; the side pieces are diagonally divided, and the epimera attain widely the base of the prothorax beneath, though they do not intervene between the elytra and the pronotum. Metasternum moderately long, side pieces narrow, wider in front. First, second, and fifth ventral segments long; third and fourth united about equal to each of them; surface rather flat, sutures fine and well impressed, nearly straight; second suture slightly curved at the sides; in the ♂, the anal segment is slightly visible at the tip of the fifth ventral. Legs rather stout, thighs compressed not toothed; tibiæ truncate at tip, not mucronate; tarsi spongy beneath;

Digitized by Google

third joint broad, deeply bilobed; claws divergent, broadly toothed in our species; simple in the foreign genera.

While having a slight relation with the *Magdalini* and *Anthonomini* this tribe adds to the characters it has in common with them and other tribes, one peculiar to itself; the prosternum very long in front of the coxæ. The space between the front coxæ is almost imperceptible in our two species, but as the descriptions of the foreign genera mention them as moderately distant, I infer that that character, as well as the form of the claws, must be regarded of small value in this tribe.

NOTOLOMUS n. g.

This new genus is sufficiently described in the characters of the tribe as detailed above. It merely remains to say that it agrees entirely with *Derelomus* in appearance, but differs by the nearly contiguous front coxæ, and broadly toothed claws. From the South American *Everges*, it abundantly differs by the form of body.

Two species are known to me, both affecting the palmetto tree of the Southern maritime region:

Testaceous, head and prothorax black.................... 1. **bicolor.**
" ; elytra with an oblique dark band near the base 2. **basalis.**

1. N. **bicolor**, n. sp.

Testaceous, head, beak and prothorax black. Beak slender, as long as the prothorax, slightly curved, finely punctured, with a narrow, indistinct smooth dorsal line, head similarly punctured. Prothorax finely punctured, as wide as long, sides parallel for three-fourths the length, where there is a distinct lateral angle produced by the posterior extremity of the small, oblique ridge mentioned above; the outline then is oblique, converging rapidly to the tip, which is constricted at the sides; tip truncate, not reflexed, base bisinuate. Scutellum triangular, black, punctulate. Elytra testaceous, with two transverse bands slightly darker; surface punctulate, with distant rows of larger punctures, representing the striæ. Meso- and metathorax, legs and antennæ testaceous, the latter more slender than in the next species, with the second joint of the funicle longer than the third. Length 2.3–4 mm.; .08–.14 inch.

Enterprise and Capron, Florida; April and May; Messrs. Hubbard and Schwarz. On *Chamærops palmetto;* less abundant than the next species.

2. N. **basalis**, n. sp.

Testaceous, head and beak brown; elytra with an oblique dark band commencing near the base of the third interspace, and running to the suture. Beak moderately curved, slender, punctured. Prothorax as long as wide, finely punctured, strongly constricted at the tip, which is truncate, base bisinuate. Elytra punctulate, with distant, indistinct rows of scarcely larger punctures. Beneath testaceous, antennæ with the funicle stouter; second joint scarcely longer than the third. Length 1.8 mm.; .075 inch.

♂. Beak as long as the prothorax, stouter than in ♀; sides of prothorax with a distinct cusp in front of the middle.

Digitized by Google

♀. Beak longer than the prothorax, more slender; sides of prothorax more strongly converging from the base, rounded and not angulated in front of the middle.

Capron and Sand Point, Florida, Messrs. Hubbard and Schwarz. On leaves of *Chamærops palmetto*, abundant; varies in having a broad, dorsal, prothoracic stripe brown; also in the elytra band becoming obsolete. This species is *Derelomus signaticollis* and *flavicans* of Dejean's Catalogue. *D. troglodytes* is smaller and entirely testaceous, but is probably only an individual variation.

Tribe XIV. LÆMOSACCINI.

This tribe is composed of a single genus *Læmosaccus*, of which one species occurs in our Southern States. It is easily known by the exposed pygidium; the large, prominent and distant front coxæ, and the breast not channeled. The side pieces of the mesothorax are very transverse, and intervene somewhat between the prothorax and elytra; the episterna of the metathorax are wide, and the epimera are visible behind. The ventral sutures are straight; first and second segments equal, longer than the third and fourth. The legs are stout and short, and the tibiæ are strongly hooked at tip; the tarsi are dilated, and the last joint is very slender, with two very small, simple claws.

The beak is short, stout and cylindrical; the antennal grooves extend to the lower margin of the eyes, which are oval and transverse. The antennæ are inserted about the middle, and are scarcely geniculated; the funicle consists of seven joints and merges gradually into the oval, annulated, pubescent club. There is nothing peculiar in the mouth; the gular peduncle is long, the mentum small, and the palpi short and small; the mandibles are curved, and of the usual form.

The affinities of this tribe seem to be in the direction of *Barini*.

LÆMOSACCUS Sch.

1. **L. plagiatus** Say, Curc. 6; ed. Lec. i, 265; Gyll., Sch. Curc. iii, 626; *Curculio pl.* Fabr. Ent. Syst. El. ii, 485; *Rhina plagiata* Oliv. 83, 234, pl. 33, fig. 512.

Var. *Curculio Nephele* Herbst, Käfer, vii, 54, pl. 99, fig. 4. *Magdalis Nephele* Germ., Ins. Nov. 192.

Middle, Western, and Southern States, as far as Texas; not rare on oak leaves. Varies in the size of the red elytral spot, which sometimes occupies the whole disc, leaving only a narrow margin black. The beak is opaque, flattened above and rugosely punctured in ♂; cylindrical, shining, and sparsely punctured in ♀.

Tribe XV. CRYPTORHYNCHINI.

This tribe contains a large number of genera, which differ so much in appearance and details of structure, that scarcely anything can be predicated of all. It may, however, be stated in general terms, that while

Digitized by Google

in common with several other tribes, the beak is received upon the sternum, and lies in repose in a pectoral groove, this tribe differs from *Zygopini* in the smaller size, and different position of the eyes, which are more or less covered by the prothoracic lobes; and from *Ceutorhynchini* by the pygidium being entirely covered.

The pectoral groove varies in length according to the group; the front coxæ are contiguous in many species of *Conotrachelus*, and other genera of the group *Ithypori*. The side pieces of the mesothorax are obliquely divided, and the epimera attain largely the base of the prothorax on the under surface, without intervening between the pronotum and the elytra. The metasternum is either long or short; the side pieces narrow, and dilated in front. The ventral segments vary in length; the first suture is straight or sinuate, deep, or obliterated; the second and third are somewhat angulated at the sides. The tibiæ are armed with a strong hook at the tip, and the articular surface is oblique; the claws are simple, or toothed.

But three groups are represented in our fauna, of which the second is established upon a new genus.

Pectoral groove confined to the prosternum, open behind:
Beak long, tarsi dilated.................................. **Ithypori.**
Beak short, tarsi narrow.............................. **Acampti.**
Pectoral groove extending to the mesosternum, sharply limited behind................................. **Cryptorhynchi.**

Group I. **Ithypori.**

In this group the pectoral groove is confined to the prosternum, and is not closed behind, the mesosternum is sometimes flat, sometimes suddenly declivous. The eyes are coarsely granulated, partly covered in repose by the prothoracic lobes, which are sometimes very well developed, but in other genera are broad and not prominent.

The prothorax is, in most species, comparatively smaller than in the other groups, and usually very coarsely sculptured. The elytra are wider than the prothorax, with prominent humeri, the outer stria is usually abbreviated, and there is a tendency to an epipleural fold. The thighs are toothed in our genera; the tibiæ slender, hooked at the tip; the claws usually toothed, though sometimes simple, or even connate at the base.

The front coxæ are sometimes contiguous, a character not observed in the other groups of this tribe.

Postocular lobes broad, not prominent.......... 2.
" " prominent, front coxæ contiguous; claws toothed; sometimes cleft........ CONOTRACHELUS.
2. Claws slender, simple...................... 3.
" approximate, toothed.................. RHYSSEMATUS.
" " connate at base.......... CHALCODERMUS.
3. Elytra at base not wider than prothorax..... ZAGLYPTUS.
" " " much wider.................. MICROHYUS.

Digitized by Google

CONOTRACHELUS Sch.

This genus contains some of the most formidable enemies of our cultivated fruits, especially the stone fruits, such as the plum, apricot, &c.

They are easily recognized by the characters given above, to which may be added the following, which serve to distinguish this from some foreign genera; the antennal grooves are not confluent behind, and the hind thighs are not pedunculated.

A singular though harmless error has been committed by Schönherr and his collaborators in describing the antennæ of most of the species as "longe pone medium rostri sitæ." Geometrically this is correct, as the rostrum when not used in feeding, or in its equally legitimate occupation as ovipositor, is inflexed upon the breast, and directed backwards; its tip is therefore in that position the posterior extremity. Morphologically, however, the beak being an extension of the longitudinal axis of the body, the tip is the anterior extremity; the word *pone* in the description should therefore have been *ultra*. The insertion of the antennæ behind the middle of the beak probably does not occur in this tribe, or group, though in some of the long beaked species of this genus (Nos. 11–13,) they attain nearly that position.

The species indicate the following divisions:

Claws divergent, toothed	2.
" approximate, cleft, (as in *Anthonomus*)	3.
2. Prothorax not sulcate, usually carinate	I.
(A. Elytral costæ interrupted; thighs bidentate:	
B. " entire, or absent, thighs unidentate).	
Prothorax broadly sulcate, with two crests in front	II.
3. Pubescence prostrate, fine	III.
" mixed with stout, erect bristles	IV.

As these divisions require fuller definitions, the synoptic table of the species will be found under each.

Division I—A. Sp. 1-9.

The species of this division are related to *C. nenuphar*, and agree with it in having the costæ of the third and fifth interspaces of the elytra more or less interrupted in two places. The prothorax is not sulcate, but usually distinctly carinate, and strongly constricted near the tip; the thighs are bidentate. These characters, except the last, are evanescent in *C. nivosus*, which shows a passage to Division II, and appears closely allied to *C. leucophæatus*.

The pubescence is short, fine and appressed; it forms a more or less complex pattern of slender pale lines each side of the prothorax, and a broad band behind the middle of the elytra. In well preserved specimens the color and distribution of the pubescence afford easy characters for the recognition of the species; but otherwise, they are closely allied, and require care in their separation.

Digitized by Google

Costæ of elytra abruptly interrupted....................	2.
" " feebly..................................	4.
2. Beak stouter, shorter and more curved..............	3.
" longer, more slender; elytral band pale yellow	1. **juglandis.**
3. Elytral band white..................................	2. **albicinctus.**
" " " and yellow........................	3. **nenuphar.**
4. Prothorax carinate..................................	5.
" with a small, median callus..............	4. **retentus.**
" not or scarcely carinate....................	6.
5. Ventral segments coarsely punctured................	5. **seniculus**.
" " finely and sparsely punctured......	6. **affinis.**
6. Costæ of elytra distinct............................	7.
" " obsolete, elytra in great part white..	9. **nivosus.**
7. Elytral band well-defined...........................	7. **elegans.**
" " not well-defined........................	8. **aratus.**

1. **C. juglandis**, n. sp.

Dark brown, varied with black, pubescence fulvous, or dirty yellow, forming a curved bifurcated line each side of the prothorax, and a broad band behind the middle of the elytra. Beak longer than the head and prothorax, cylindrical, not stout, shining, sparsely punctured, with a broad, lateral groove, and two short, finer ones near the base. Prothorax coarsely punctured and rugose, with a very short carina before the middle, and four discoidal tubercles; broadly constricted in front. Elytra with striæ of large quadrate punctures, alternate insterspaces strongly costate, the third and fifth interrupted forming on each a high crest, with a basal and sub-apical elevation. Ventral segments sparsely punctured, fifth more finely and densely. Legs somewhat annulated, thighs bidentate. Length 7 mm.; .27 inch.

Middle States, on walnut. This species is closely allied to the plum weevil, *C. nenuphar*, and has been confounded with it until the present time. It is, however, much larger, the beak is longer, more slender, and less curved; the prothorax is broader and more rounded on the sides, the crest of the fifth elytral interspace is longer, almost as large as that of the third, and overlaps it far more than half its length, and finally the pubescence is of a nearly uniform color, so that the band of the elytra is not variegated with white. The ventral segments are much less densely punctured. It is mentioned as a phytophagic species by Mr. B. D. Walsh, Illinois State Report, 1868, p. 65.

2. **C. albicinctus**, n. sp.

Closely allied to the preceding and next species. Beak longer than the prothorax, stout, curved, deeply striate and punctate. Prothorax as in the preceding, but with a complex line each side of yellow and gray hairs. Elytra as in the preceding, with the crest of the fifth interspace less elevated, and scarcely separated from the sub-basal part of the costa: posterior band broad, narrower towards the sides, composed of pure white hair;

Digitized by Google

at the base of the third interspace is a conspicuous white spot. Ventral segments coarsely and tolerably densely punctured; fifth more densely, a little less coarsely. Thighs annulated, bidentate. Length 4.7 mm.; .19 inch.

Southern States, Georgia to Texas; four specimens.

3. **C. nenuphar** Harris, Ins. Inj. to Veg. 1st ed. p. 67: 3d ed. p. 75: *Rhynchænus nen.* Herbst, Käfer, vii, 29, pl. 99. f. 8: *Rhynchænus argula* Fabr., Syst. El. ii, 467; Oliv., Ent. No. 83, 192, pl. xxii, f. 301: *Rhynch. cerasi* Peck, Mass. Agr. Repos. 1819, 307. *Conotrachelus arg.* Fahræus, Sch. Curc. iv. 425.

Found over the Atlantic slope, wherever the plum is cultivated or native. It attacks also other stone fruit, and is said to infest apples, pears and quinces (Harris loc. cit). Further observations on this point are desirable, as it is very unlikely that such different plants are attacked by the same species. The crests of the elytra are more abrupt, and the posterior ones more prominent than in the two preceding; the second elevation of the fifth interspace in front of the middle is conspicuously smaller than that of the third interspace, and does not overlap it as much as in *C. juglandis*. The elytral band is composed of yellow and white hair; there is a conspicuous white line at the base of the third interspace. The thorax is longer and less rounded on the sides, than in the two preceding. The beak is stout, curved, and strongly striate and punctured; the ventral segments coarsely and densely punctured; fifth with two setigerous tubercles; I have many specimens before me, which show no variation worthy of note.

An excellent memoir on this pernicious insect by the late B. D. Walsh will be found in the Practical Entomologist, ii, 75; and some additional remarks in the First Annual Report of the State Entomologist of Illinois, 1868, p. 64.

4. **C. retentus** Boh., Sch. Curc. iv, 442, (*retensus* err. typ.); *Cryptorhynchus retentus* Say, Curc. 27; ed. Lec. i, 295.

Kansas; one specimen, Mr. Popinœ. A large species of nearly black color, clothed nearly uniformly with short, dark gray pubescence. The beak is long, slightly curved, strongly striate and punctured. The prothorax is densely rugosely punctured, with a small median callus, and some indistinct tubercles; each side is a vague curved line of pubescence; the sides are much rounded, and strongly constricted in front. The elytra are striate with distant quadrate punctures, the alternate interspaces are moderately carinated, the third and fifth are each interrupted twice, and the seventh broadly interrupted behind the humerus. Ventral segments sparsely punctured; fifth more densely and finely punctured. The thighs are distinctly bidentate. Length 7 mm.; .28 inch.

5. **C. seniculus**, n. sp.

Beak short, stout, curved, strongly punctured and striate, as in *C. nenuphar*. The prothorax is wider than long, constricted in front, rounded on the sides, strongly rugosely punctured, and very distinctly carinate from the tip nearly to the base; each side is a straight, oblique line of

Digitized by Google

fuscous pubescence, united at the tip. Elytra with fuscous or grayish pubescence, more condensed into a transverse band behind the middle, alternate interspaces carinate; third interrupted in two places; fifth interrupted at the pubescent band; two outer carinæ rather indistinct; striæ composed of large, distant quadrate punctures. Thighs not annulated, with one large, acute tooth, and one small denticle. Length 4.6 mm.; .18 inch.

Middle and Western States; Texas. Of the same form and size as *C. nenuphar;* it is distinguished from the next species chiefly by the broader, more strongly carinate prothorax; by the two lines of pubescence being straight, and meeting at the front margin; and by the first ventral segment being less punctured than the others. It is *C. seniculus* ‡ Dej. Cat.

6. **C. affinis** Boh., Sch. Curc. iv, 429.

Of the same form as *C. elegans*, but larger, with the thorax similarly sculptured, more deeply constricted in front, distinctly carinate from the tip to the middle, with a transverse discoidal impression about the middle; sides broadly rounded, pubescence brownish yellow, lines broad, curved, sinuate, and irregularly branching on the disc and sides. Elytra thinly pubescent, with a short basal line on the third interspace, and a broad posterior band brownish yellow; first carina broadly interrupted in two places; second feebly interrupted near the base; third feebly interrupted in front of the middle in one specimen, but not in the other; striæ composed of large, distant, quadrate punctures. Beak long, slender, strongly striate and punctured. Thighs with two small, acute teeth, annulated. Ventral segments shining, sparsely and not coarsely punctured; fifth with two inconspicuous tubercles. Length 5–7 mm.; .2–.27 inch.

Western States, two specimens, of which one was sent by the late B. D. Walsh. The more sparsely and less coarsely punctured ventral segments distinguish this easily from all the neighboring species.

7. **C. elegans** Boh., Sch. Curc. iv, 428; *Cryptorhynchus el.* Say, Curc. 18; ed. Lec. i, 288.

Of the same form, size and color, as *C. seniculus*, but the beak is longer and less curved; the prothorax is narrower, feebly carinate, and faintly tuberculate; the lines of pubescence are narrow, curved, and do not meet at the front margin. The carinæ of the elytra are quite similar, except that the second one (that of the fifth interspace) is not interrupted behind at the transverse band; the pubescence is more yellow, and less mixed with gray. The teeth of the thighs are small, acute, and nearly equal. The ventral segments are more coarsely punctured than in *C. affinis*, and the first is not less so than the others.

8. **C. aratus** Germar, Sp. Nov. (*Cryptorhynchus*), 283; Boh. Sch. Curc. viii, 2, 26.

I refer, with some hesitation, to this species, a specimen collected in Texas by Belfrage, which resembles *C. retensus* in form, color, and sculpture, but is much smaller, (4 mm.; .16 inch), and has the carina of the fifth interspace not interrupted near the base. It differs from all the other

Digitized by Google

species in the group by the punctuation of the ventral segments; first and second very coarsely but not densely punctured; third and fourth strongly punctured; fifth finely and more densely punctured, with two distinct tubercles as in *C. nenuphar*. The thighs are armed with two small acute denticles.

9. **C. nivosus**, n. sp.

Rather stouter than *C. elegans*, brown varied with black, pubescence white varied with fine chocolate brown. Beak short, stout, curved, finely punctured and striate. Prothorax not wider than long, broadly rounded on the sides, moderately constricted near the tip; very coarsely but not densely punctured, not carinate; with a complex white reticulation each side connected transversely on the disc in front of the middle; a short posterior dorsal line white. Elytra with striæ composed of large, distant quadrate punctures, interspaces flat; surface in great part white, with a transverse, common basal spot, (a continuation of the brown thoracic disc), and large, apical space brown; there is also a transverse band at the middle, which is variegated brown and white, dilated into a large, sutural brownish blotch; all these markings are connected at the suture. Body beneath densely brown-pubescent, metasternum and side pieces white; ventral segments, 1–4 each with a white spot near the sides, coarsely punctured; fifth with two basal white spots, finely and densely punctured. Legs annulated, thighs with one tooth and a small denticle. Length 5 mm.; .20 inch.

Colorado, abundant. This species resembles somewhat in appearance the Texan and Mexican *C. leucophætus*, but is not otherwise allied to it.

DIVISION I—B. Sp. 10–18.

The species of this division differ from the preceding, chiefly by the alternate interspaces of the elytra being elevated, and not interrupted into short, abrupt crests; the inner one (of the third interspace) is in every case entire. In other respects they resemble those of the preceding division in several important characters; the prothorax is more or less carinate, not grooved; the surface is finely pubescent, with, at most, lines of very short bristles on the elytra. On the other hand, the thighs are armed with a single, usually acute tooth, without a trace of the second tooth or denticle.

a. Humeri dentiform; ventral segments 2–4 sparsely punctured.. **10. cratægi.**

b. Humeri not dentiform; ventral segments densely and coarsely punctured; beak long and slender; antennæ inserted about the middle; prothorax punctured, not cribrate, mesosternum protuberant.

Prothorax strongly constricted in front............... **2.**

" " " " " gradually narrowed; pubescence yellow-gray, speckled with white **11. adspersus.**

2. Femoral tooth large, acute; white markings conspicuous, without intermixed bristles................. **12. similis.**

Femoral tooth obtuse; pubescence intermixed with bristles.. **13. naso.**

c. Humeri not dentiform; beak shorter, strongly striate; antennæ inserted about one-third from the tip.

Ventral segments nearly uniformly punctured........ **2.**

" " sparsely, fifth finely and densely punctured; prothorax sparsely cribrate, elytra with large, white markings.......................... ..... **18. plagiatus.**

2\. Mesosternum flat, declivous........................ **3.**

" prominent; prothorax densely and coarsely punctured............................... **14. posticatus.**

3\. Prothorax plicate towards the middle.............. **4.**

" uniformly cribrate........................ **15. geminatus.**

4\. Plicæ approximate; pubescence short.... .... **16. infector.**

" coarser, and more reticulate, pubescence mixed with longer bristles .... **17. cribricollis.**

10\. **C. cratægi** Walsh, Proc. Bost. Soc. Nat. Hist. ix, 1863, 311.

New York, Georgia, Illinois. The form is broader and more squat than in any other of our species, and it is easily distinguished by the humeri being obliquely truncate, with the outer angle dentiform; this appearance is produced by a short carina between the third and fourth elevated ridge of the elytra, which meets the fourth ridge at an acute angle. The beak is punctured and very deeply striate; head densely punctured; prothorax carinate, elevated at the middle, broadly transversely impressed in front, densely and finely cinereous pubescent, with an indistinct pattern of paler pubescence each side, meeting in front of the middle. The elytra are clothed with dirt-colored, slightly mottled, fine pubescence, with rows of short, whitish setæ; the third, fifth, seventh and ninth interspaces are strongly carinate, leaving broad furrows, each marked with two rows of quadrate punctures. The body beneath is thinly clothed with yellowish pubescence, sparsely punctured and cribrate; the third and fourth ventral segments still more sparsely, and the fifth rather densely punctured. Thighs armed with a large, not very acute tooth. The middle coxæ are more widely separated than in the other species. Length 5 mm.; .20 inch.

The beak of the female is a little longer and less deeply striate than in the male; the last ventral segment in both sexes is foveate each side, and feebly impressed at the middle near the tip; but these impressions are broader in the female.

It is *C. humeralis* Dej. Cat.

11\. **C. adspersus**, n. sp.

Black, robust, clothed with very short, prostrate scale-like yellow pubescence, with lines on the prothorax, and dots on the elytra of white pubescence. Beak half as long as the body, slender, slightly curved, punctured, not striate. Prothorax as long as wide, gradually narrowed in front from the base, feebly rounded on the sides, slightly constricted in front; slightly

Digitized by Google

carinate; punctures large, shallow, indistinct on account of the pubescence. Elytra one-half wider at base than the prothorax, humeri prominent, abruptly rounded; striæ composed of distant, oblong punctures; interspaces finely rugose, flat; third, fifth, seventh and ninth finely but not strongly carinate. Body beneath coarsely punctured; mesosternum protuberant; last ventral segment with three very faint impressions. Thighs feebly annulated, with a broad, obtuse tooth. Length 7 mm.; .28 inch.

Kansas, Mr. E. A. Popinoe, one specimen. The rows of punctures of the elytra, from the absence of pubescence, appear black; the white dots occupy the distance between them, and contrast elegantly with the yellow pubescence of the main surface. The white lines of the prothorax are narrow, and not very conspicuous; they converge but scarcely meet at the front, and are slightly curved; the middle carina is also clothed behind with white hair; the scutellum and a small spot at the base of the third interspace of the elytra are also white.

12. C. **similis** Boh., Sch. Curc. iv, 416.

Southern States. A large, (6.2 mm.; .25 inch), and robust species clothed with short, ferruginous pubescence, and handsomely variegated with white, forming a complex pattern each side of the prothorax, and irregular posterior bands on the elytra. The beak is long and slender, punctured, feebly striate; the prothorax broader than long, not narrowed from the base to the middle, then rounded and much narrowed to the tip, which is strongly constricted at the sides; the disc is very densely punctured, and finely carinate from the tip to the middle. The punctures of the elytral striæ are very large and quadrate, and the alternate interspaces are finely carinate. Body beneath coarsely and rather densely punctured; mesosternum protuberant; abdomen with three rows of more densely pubescent spots; first and second ventral segments more sparsely at the sides; fifth ventral feebly impressed at the tip. Thighs armed with a large, acute tooth.

The beak in the ♂ is half as long as the body, opaque, punctured, finely striate towards the base, with the antennæ inserted about one-third from the tip; in the female the beak is much longer, about three-fourths the length of the body, polished, not striate, feebly and sparsely punctured, with the antennæ inserted behind the middle.

13. C. **naso**, n. sp.

Blackish brown, thinly clothed with dirty brown pubescence. Beak brown, slender, curved, one-half as long as the body, shining, indistinctly punctured, finely striate towards the base. Prothorax wider than long, rounded on the sides, suddenly narrowed and constricted near the tip; very densely, rugosely punctured, carinate, marked with two small discoidal spots of white pubescence. Elytra one-third wider than the prothorax, more sinuate at base than usual, humeri more advanced in front, and rounded; striæ composed of small, closely placed quadrate punctures, alternate interspaces finely carinate; surface more densely pubescent, and with rows of very short bristles, indistinctly banded transversely. Under surface

Digitized by Google

densely, coarsely punctured; mesosternum protuberant; last ventral segment with a round impression near the tip. Thighs annulated, front and middle pair not toothed; hind pair very obtusely toothed. Length 6 mm.; .24 inch.

Georgia and Texas. I perceive no sexual differences in the four specimens in my collection.

14. C. **posticatus** Boh., Sch. Curc. iv. 406.

Southern States; the references to Say given by Boheman, and copied in Gemminger and Harold, should be hereafter omitted, as was done in the Melsheimer Catalogue; no description was ever published by Say, and the citation from the Journal of the Academy of Natural Sciences of Philadelphia is erroneous. This species resembles in appearance *C. naso*, but differs by the shorter and strongly striate beak, the different position of the antennæ; by the coarser punctuation of the prothorax, which is less suddenly narrowed and less constricted in front, and not marked with two discoidal spots of white pubescence; by the elytra having the humeri, and sides more rounded; and finally by all the thighs being strongly though not acutely toothed. The under surface is very coarsely punctured, and the last ventral segment has a broad, rounded impression. The mesosternum is protuberant and perpendicular in front, as in the species of Division II, and in the three preceding species. In some specimens the elytral interspaces are equally, finely carinate; in others the alternate carinæ are obsolete.

15. C. **geminatus** ‡ Dej. Cat. 322: *puncticollis* ‖ Walsh, Proc. Bost. Soc. Nat. Hist. ix, 1863, 310.

Maryland, Illinois, Kansas. Related to the next three species, but easily distinguished by the prothorax being densely and uniformly cribrate, not at all plicate; the striæ of the elytra are composed of large, quadrate punctures, interspaces broad and flat; the third and fifth are slightly elevated behind the middle; the seventh is subcarinate near the humeri, which are somewhat obliquely rounded; the pubescence is yellowish, very thin and fine, mottled with grayish bands, with a white spot at the base of the third interspace, and rows of very short bristles. Body beneath coarsely punctured; ventral segments 3–5 more finely, but not very densely punctured; fifth not impressed in ♂; with a shallow but well defined circular impression at the tip in ♀; in the only specimen of the latter sex in my collection, the second ventral segment is also transversely elevated, and declivous behind; this, however, may be a deformity. Thighs armed with a large, obtuse tooth. Length 4.2 mm.; .17 inch.

16. C. **infector** Boh., Sch. Curc. viii, 2, 49.

One specimen, New York. Of the same size, form and color, as the preceding, but with the prothorax distinctly carinate, and more coarsely sculptured; the cribrate punctures being confluent, so as to leave longitudinal ridges; the quadrate punctures of the elytral striæ are more approximate; the interspaces narrower and somewhat convex, and the pubescence more yellow, and not mixed with gray. The under surface is uniformly and coarsely punctured; last ventral segment not impressed.

Digitized by Google

17. C. **cribricollis** *Cryptorhynchus cribr.* Say, Curc. 28; ed. Lec. i, 296: Boh., Sch. Curc. iv, 446.

New York, Louisiana, Texas. Also of the same form and size, but with the sculpture of the prothorax much coarser, so that the surface appears reticulate; the pubescence of the elytra is coarser, and the bristles longer and more numerous. The punctures of the striæ are large, quadrate and approximate, and the interspaces slightly convex. Body beneath coarsely and densely punctured, last ventral segment not impressed; thighs acutely toothed.

18. C. **plagiatus**, n. sp.

Black, variegated with ferruginous pubescence, elytra in great part, and metasternum densely clothed with small, white scales. Beak as long as head and prothorax, stout, curved, punctured and pubescent, feebly striate. Prothorax as long as wide, rounded on the sides, narrowed, but scarcely constricted at tip, coarsely but not densely cribrate, not carinate, mottled with ferruginous and white spots. Elytra one-half wider than prothorax at base, humeri abruptly rounded, disc convex, striæ composed of large punctures, interspaces nearly flat; an irregular humeral patch, and a very broad band about the middle, not extending to the suture, and the sides from the base to behind the middle are white; rest of the surface mottled, ferruginous and white. Metasternum white, abdomen with lateral spots of denser pubescence; under surface very sparsely cribrate-punctate, punctures very few on the ventral segments 1–4; fifth finely and densely punctured, with a large, shallow circular impression. Legs annulated; thighs armed with an obtuse tooth, and a feeble trace of a denticle; mesosternum not protuberant. Length 4 mm.; .16 inch.

Texas, Belfrage; one specimen.

DIVISION II. Sp. 19–21.

In this division the form is rather squat, the elytra at base being nearly twice as wide as the prothorax; the latter is coarsely sculptured, and has two crests in front of the middle, between which is a wide furrow. The beak is curved, a little longer than the head and prothorax, strongly punctured and striate. The alternate interspaces of the elytra are strongly carinated, and sometimes abruptly interrupted. The under surface is very coarsely punctured; the mesosternum horizontal and protuberant in front; the legs are annulated; the thighs armed with a large tooth and a small denticle.

Three species are known to me, which may be tabulated as follows:

	Elytral costæ entire, or nearly so................	2.
	" " abruptly interrupted..............	19. **tuberosus.**
2.	Elytra mottled, strongly costate..................	20. **anaglypticus.**
	" in great part white, feebly costate........	21. **leucophæatus.**

19. C. **tuberosus**, n. sp.

At first sight this species resembles closely *C. nenuphar*, but it is smaller and stouter, and the sculpture of the prothorax is very different. The

Digitized by Google

beak is more strongly striate; the prothorax is longer than wide, slightly rounded on the sides; densely, rugosely punctured, opaque, with two acute crests running from the tip to the middle; each side are two narrow, white lines, crossed by a curved one in front of the middle. The elytral striæ are composed of large, quadrate punctures, and the costæ are interrupted almost exactly as in *C. nenuphar;* the pubescence is very fine, short and fulvous, condensed into a narrow, transverse band just behind the middle. Antennæ, tibiæ and tarsi ferruginous. Length 3 mm.; .12 inch.

South Carolina; Dr. Zimmermann; Illinois, Dr. Horn. There are scarcely perceptible rows of short bristles on the elytra.

20. **C. anaglypticus** Fahræus, Sch. Curc. iv, 418; *Cryptorhynchus anagl.* Say, Curc. 18; ed. Lec. 282.

Massachusetts to Kansas; Georgia, Texas; abundant. I have one very small specimen in which the color is concealed by a uniform dirt-colored crust; it is *C. ineditus* ‡ Dej. Cat.

21. **C. leucophæatus** Fahræus, Sch. Curc. iv, 417.

Described first from Mexico, but not rare in Texas. Allied to *C. anaglypticus*, but larger, (nearly 5 mm.; .20 inch), with the sculpture of the prothorax coarser, the crests more evident, and a short median carina; the elytral costæ are less elevated, and the surface is in great part covered with white pubescence to within one-fourth of the tip, which is dark brown and mottled; the base for a short distance is clothed with fulvous pubescence.

Division III. Sp. 22.

This division contains but a single species of ordinary form, with the elytra covered in great part with very fine, short pubescence, not mixed with longer hairs, or with bristles. The beak is rather stout and slightly curved; the front coxæ are contiguous, the thighs obtusely toothed, and sinuate beneath near the knee; the claws are cleft at tip, and less approximate than in the next division. The antennæ are inserted about one-fifth from the end of the beak. The mesosternum is not very wide; the hind part is obliquely declivous; the front part perpendicular.

22. **C. fissunguis**, n. sp.

Dark brown, nearly black. Beak stout, as long as the head and prothorax, punctured, shining towards the tip, then carinate and coarsely striate. Prothorax coarsely and deeply cribrate, towards the tip with longitudinal ridges, the middle one of which is more distinct; scarcely longer than wide, slightly rounded on the sides, then more strongly rounded and narrowed to the apex, which is feebly constricted at the sides. Elytra one-half wider than the prothorax, base truncate, humeri prominent, nearly rectangular; sides parallel, then obliquely narrowed to the tip; striæ composed of large, distant punctures; surface densely covered with short, yellow pubescence, which is darker on the posterior fourth; a denuded transverse band about the middle. Beneath coarsely punctured; thighs annulated with yellow pubescence. Length 5–5.5 mm.; .20–.22 inch.

Louisiana, three specimens.

Digitized by Google

Division IV. Sp. 23–24.

This division contains small species of less robust form, easily known by the fine pubescence being mixed with long, stout, erect bristles. The beak is longer than the head and prothorax, not stout, very slightly curved, punctate and striate; antennæ inserted one-fourth from the tip; mesosternum rather wide, perpendicularly declivous in front. Under surface coarsely, uniformly punctured; thighs armed with one tooth, claws cleft, the tooth being as long as the outer part. Elytra not costate. Front coxæ contiguous as usual.

Prothorax coarsely cribrate.......................... **23. erinaceus.**
" punctured................................ **24. hispidus.**

23. C. erinaceus, n. sp.

Blackish, densely clothed with depressed mud-colored, scaly pubescence, with erect bristles intermixed, which are short on the prothorax, and long on the elytra. Legs, antennæ and beak brown; the last named slender, slightly curved, sparsely punctured, feebly striate towards the base. Prothorax wider than long, slightly rounded on the sides, moderately narrowed in front, and feebly constricted; tolerably densely cribrate. Elytra one-third wider than prothorax, humeri prominent, abruptly rounded, striæ composed of large, shallow punctures, interspaces slightly convex. Body beneath shining, sparsely pubescent, coarsely not densely cribrate; last ventral segment not impressed. Thighs armed with an obtuse tooth. Length 3 mm.; .12 inch.

Southern States. Judging from MS. drawings made by my father, this is *Cœlosternus erinaceus* ‡ Dej. Cat. 318.

24. C. hispidus, n. sp.

Of the same form as the preceding but smaller, brown covered with cinereous, scaly pubescence; prothorax not wider than long, coarsely punctured, with the bristles not shorter than those of the elytra; elytra about one-third wider than the prothorax, rather more elongate than in *C. erinaceus*, striate and setose in a similar manner. Body beneath similarly punctured, beak, antennæ and legs paler brown, femoral tooth smaller and more acute. Length 2.5 mm.; .10 inch.

One specimen, Georgia.

MICRALCINUS* n. g.

A species from Florida which has an almost deceptive resemblance to *Tyloderma variegatum*, constitutes this genus. It is closely allied to *Conotrachelus*, and has the antennal grooves confluent behind in a similar manner. The front coxæ are also nearly in contact, but the form of body is quite different, the elytra are not suddenly wider than the prothorax, regularly oval, and emarginate at base; the beak is shorter, scarcely longer than the prothorax, and the claws are not toothed. The postocular lobes are as

*This genus does not appear in the table of genera, as it was overlooked when the form was closed.

Digitized by Google

large as in *Conotrachelus*, and the mesosternum is protuberant and perpendicular in front.

1. **M. cribratus**, n. sp.

Black-brown, shining, sparsely pubescent, mottled on the elytra with small spots of fine gray hair, and towards the tip with patches of a brown color. Beak rather stout, scarcely as long as the prothorax, deeply grooved and punctured, head punctured. Prothorax as long as wide, rounded on the sides, narrowed in front, and feebly constricted: cribrate with large deep punctures; with a small smooth callus at the middle. Elytra oval, emarginate at base, about one third wider than the prothorax; humeri rounded; sides slightly rounded, more obliquely towards the tip; striæ composed of large deep punctures, becoming smaller towards the tip, where the striæ are somewhat impressed. Beneath strongly, not densely punctured. Antennæ brown, second joint of funicle nearly as long as the first; thighs slender, sinuate beneath, not toothed; tibiæ nearly straight, armed with a terminal hook; claws small, divergent, simple. Length 3.2 mm.; .12 inch.

Capron, Florida; Messrs. Hubbard & Schwarz.

RHYSSEMATUS Sch.

Concerning this genus I have little to add to the excellent synoptic table and remarks published by Dr. Horn, (Proc. Am. Phil. Soc. 1873, 463) except that the differences between it and *Chalcodermus* as stated by Lacordaire are somewhat illusive; the corbels of the hind tibiæ seem in some specimens of *R. lineaticollis* to be quite distinct. On the other hand, there is a great difference in the form of the claws, which in *Rhyssematus* are cleft as in *Anthonomus*, but in *Chalcodermus* are approximate and connate at base, almost as in *Smicronyx*, &c. There is also an important difference in the two outer striæ of the elytra, which are separated by a costa in the first, just as in *Conotrachelus*, but in the latter the outer striæ consists of only a few large punctures extending one-third the length from the base, and the interspace is flat.

In view of the importance of these characters it becomes necessary to place *Chalcodermus pruinosus* Boh., (Sch. Curc. viii, 2nd, 13) in this genus; from the other species it is easily distinguished by the less rugose punctuation of the prothorax.

CHALCODERMUS Sch.

The remarks of Dr. Horn upon the three species of this genus which remain after removing *C. pruinosus* leave nothing to be added.

ZAGLYPTUS n. g.

The two very small species which constitute this genus resemble in form and coarseness of sculpture *Rhyssematus*, but differ essentially by the antennæ and tarsi. The prothorax is also more strongly sinuate, and much more deeply margined at the base. The funiculus is rather short, with the

Digitized by Google

first joint stouter and elongated, the others are short, closely connected, so as to appear indistinct, and gradually pass into the club, which is elongate oval, in one species, and elongate ovate and obtuse in the second; the number of short joints under a high power is six, and they do not differ in length, but gradually increase in thickness. The beak is as long as the head and prothorax, slightly curved, stouter in one species (sex?) than in the other. Prothorax gradually narrowed from the base forwards, strongly constricted and tubular at tip, without postocular lobes, not emarginate beneath; the base is strongly sinuate and margined, scutellar lobe acute. Elytra ample, convex, a little wider than the prothorax at base, gradually narrowed behind from the humeri which are rather prominent. Pectoral groove shallow, antecoxal ridges very fine; prosternum prominent and foveate behind the front coxæ which are moderately distant; mesosternum short, declivous, not prominent, middle and hind coxæ widely separated. Ventral segments, first and second very large, connate, with the suture obliterated at the middle; third and fourth short, sutures deep, nearly straight; fifth as long as third and fourth united, rounded behind, flat. Legs rather short, slender, thighs unarmed, tibiæ slightly mucronate at tip, tarsi with the third joint emarginate, not broader than the preceding; last joint as long as the others united; claws slender, divergent, not toothed.

1. **Z. sulcatus**, n. sp.

Dark reddish brown; head and tubular constriction of prothorax smooth, beak deeply sulcate each side; prothorax very coarsely cribrate, sparsely pilose with long, erect whitish hairs. Elytra deeply sulcate, grooves punctured, interspaces narrow, convex, each with a row of distant, small punctures, from which proceed long, erect hairs; disc from base to behind the middle red. Trunk and first ventral segment with very large, sparse punctures. Length 1.8 mm.; .07 inch.

One specimen from Mobile, Alabama, given me by the late Col. Motschulsky, under the MS. name *Nanophyes rubidus.*

2. **Z. striatus**, n. sp.

Of the same form and sculpture as the preceding, somewhat lighter in color. Beak more slender (a sexual character?), less deeply sulcate, with two or three long hairs each side near the base. Prothorax with more numerous erect hairs. Elytra with coarsely punctured shallow striæ, interspaces wide, flat, each with a series of long, pale, erect hairs proceeding from scarcely perceptible punctures. Length 1.8 mm.; .07 inch.

One specimen, Pennsylvania; Mr. S. S. Rathvon. The essential difference between this and the preceding is in the elytral sculpture. The other characters are dependent on sex, and on better preservation of the specimen.

MICROHYUS n. g.

As the preceding genus resembles *Rhyssematus* in miniature, so does this resemble the smaller, setose *Conotracheli*, but differs chiefly in the funiculus of the antennæ and the simple, divergent claws. The beak is shorter than the prothorax, nearly straight, with the antennæ inserted about one-

Digitized by Google

third from the tip. Scape scarcely reaching the eyes which are small and lateral; funiculus rather short; first joint larger and stouter, six remaining joints short, slightly increasing in thickness, closely united; club large, oval-pointed, annulated. Prothorax gradually narrowed from the base, broadly constricted near the tip, feebly rounded on the sides; postocular lobes wanting. Elytra ovate, convex, broader and sub-truncate at base, humeri prominent, gradually narrowed behind, and strongly declivous. Prosternum deeply emarginate in front, pectoral groove deep, antecoxal ridges strongly developed; front coxæ moderately distant. Mesosternum declivous; middle and hind coxæ widely separated; metasternum short. Ventral segments with straight, distinct sutures; first a little longer than the second; third and fourth shorter; fifth flat, rounded behind, as long as the second. Legs slender, rather short, thighs not toothed, tibiæ slightly mucronate at tip; tarsi with the third joint broad, bilobed; last joint as long as the others united; claws slender, divergent, not toothed.

1. **M. setiger**, n. sp.

Black, covered with a dirty crust, and clothed with stout bristles, erect on the prothorax, reclinate on the elytra. Head and beak rather finely punctured. Prothorax strongly punctured. Elytra with deep striæ, interspaces somewhat convex; the alternate ones a little wider. Beneath coarsely and densely punctured. Length 2.1 mm.; .085 inch.

Two specimens, Georgia.

Group II. Acampti.

As *Camptorhinus* differs from the *Cryptorhynchi* by the pectoral groove being confined to the prosternum, though distinctly limited behind, so is the singular insect which constitutes this group similarly separated from the *Ithypori*, by the shorter beak resting upon the front coxæ. The body is elongate, as in *Camptorhinus*, and the tibiæ are stout, sinuate on the inner side, and strongly hooked at the tip. The other characters are peculiar, the tarsi are not dilated nor spongy beneath, and the club of the antennæ is pubescent and sensitive only near the tip.

These characters indicate relationships in various directions, such as the *Byrsopidæ* and *Cossonidæ*, but the insect preserves unchanged all the essential characters of the Cryptorhynch type of *Curculionidæ*.

ACAMPTUS n. g.

A very singular species of elongate form, clothed with dirt-colored hair, and short, erect bristles represents this genus.

The beak is short and stout, as long as the head, and expanding gradually into it, so that no distinct separation appears; the antennal grooves begin about one-third from the end, and descend obliquely to the eyes, which are small, lateral, and not prominent. Antennæ with the scape extending to the front margin of the eyes, clavate; funiculus not longer than the scape; first joint stouter and about as long as its width; remaining joints five, short, gradually increasing in width, closely connected, passing

Digitized by Google

gradually into the club which is elongate, obtuse at tip, corneous at base, pubescent on the outer half. Prothorax longer than wide, gradually narrowed in front; broadly, but not deeply constricted in front, slightly produced at the middle, postocular lobes not well marked, base feebly sinuate. Elytra a little wider than the prothorax, humeri rectangular, slightly rounded, sides parallel, rounded at tip. Prosternum deeply and broadly emarginate in front, pectoral groove broad and deep, antecoxal ridges very prominent, front coxæ very prominent, narrowly separated, supporting the end of the beak; prosternum behind the coxæ not prominent; mesosternum small, middle coxæ narrowly separated; hind coxæ distant, metasternum with the anterior process nearly acute; hind margin broadly emarginate; ventral sutures straight; third and fourth segments short, the others longer. Legs short, stout, thighs not toothed; tibiæ sinuate on the inner side, strongly armed at tip; tarsi as long as the tibiæ, not dilated nor spongy beneath; last joint as long as the two preceding; claws slender, divergent, not toothed.

1. **A. rigidus**, n. sp.

Elongate, black, covered thickly with dirty brown hair, and short, erect, stout bristles, which conceal the sculpture. Prothorax longer than wide, slightly rounded on the sides, broadly constricted near the apex, which is rounded; base feebly bisinuate; dorsal channel faint. Elytra about one-fourth wider than the prothorax, cylindrical, rounded behind; striæ composed of quadrate punctures; first, third, fifth and seventh interspaces wider, more prominent, and furnished with conspicuous rows of bristles; eighth and ninth with a few bristles; second, fourth and sixth very narrow, not prominent. Beneath, very coarsely punctured, covered with a dirt-colored crust, with scattered, short, coarse hairs. Length 3–4 mm.; .12–.16 inch.

South Carolina to Texas, not uncommon. Judging from a MS. drawing by my father, it is *Botrobatys troglodytes* ‡ Dej. Cat.

Group III. **Cryptorhynchi.**

In this group the pectoral groove is distinctly limited behind. The other characters are variable, though the front coxæ are never contiguous as in some *Ithypori;* a slight appearance of an epipleural fold exists in many species. The claws are toothed in *Phyrdenus*, but simple, and generally small in the other genera.

The genera in our fauna are not numerous, but present several categories indicating sub-groups, which it is unnecessary to define at present, as their number would be increased by a careful study of exotic forms. *Micromastus* might be placed with equal propriety in *Ithypori*, near *Arthrostenus*, but for the present I prefer associating it with *Acalles:* the only specimen in my collection is much broken.

	Metathoracic epimera distinct..................................	6.
	" " indistinct..................................	2.
2.	Metasternum as long as first ventral segment..................	5.
	Metasternum very short, humeri rounded......................	3.

Digitized by Google

3. Club of antennæ annulated..............	4.
" of antennæ solid..................	EURHOPTUS.
4. Claws very small, approximate..........	ACALLES.
" larger, divergent.................	MICROMASTUS.
5. " slender, divergent................	PSEUDOMUS.
6. Tibiæ strongly compressed..............	9.
" slender, more or less sinuate......	7.
7. Mesosternum deeply emarginate.........	8.
" feebly "	TYLODERMA.
8. Claws appendiculate, divergent..........	PHYRDENUS.
" simple, divergent..................	CRYPTORHYNCHUS.
9. Tibiæ not serrate......................	10.
" more or less serrate..............	ZASCELIS.
10. First ventral suture deep................	CŒLOSTERNUS.
" " " sinuate, faint at the middle................................	BAROPSIS.

ACALLES Sch.

The very short metasternum, with indistinct episterna, the oval elytra with rounded sides, and the small tarsal claws will enable the species of this genus to be easily recognized. The mesosternum is usually deeply excavated for about one-half its length, so that the pectoral groove ends about the anterior limit of the middle coxæ; but this is not the case with *A. nuchalis* and *pectoralis;* the hind part of the mesosternum is protuberant, so as to make an obtuse angle with the metasternum. The distance from the middle to the hind coxæ is not greater than from the middle to the front pair; the mesosternum at the side appears longer than the metasternum, a very unusual character in Coleoptera. The last two species described below are anomalous, and when studied in connection with the foreign species, will probably be considered as constituting new genera; in *A. nuchalis* the metathoracic side pieces are as distinct as in *Cryptorhynchus;* in *A. pectoralis*, the mesosternum is scarcely more emarginate than in *Tyloderma*.

Mesosternum deeply emarginate....................	2.
" broadly "	12.
2. Scales thick, erect, without intermixed bristles......	3.
" appressed, with bristles intermixed..........	7.
3. Elytra with conspicuous pale markings............	4.
" not conspicuously marked..................	5.
4. Black, with large, posthumeral spot, and band behind the middle of elytra white..................	1. nobilis.
Black, with sub-basal band and a few spots white..	2. basalis.
5. Elytra not tesselated.............................	6.
" with brown scales, tesselated with paler.....	3. porosus.
6. Interspaces of elytra moderately wide..............	4. turbidus.
" " very narrow..................	5. clathratus.

Digitized by Google

7.	Prothorax carinate, bristles short..................	8.
	" not carinate...........................	9.
8.	Basal angles of elytra not prominent..............	**6. carinatus.**
	" " " well defined.................	**7. granosus.**
9.	Bristles stout, clavate...........................	10.
	" soft, slender............................	**8. sordidus.**
10.	Elytra with basal and broad posterior band of yellow scales..	11.
	Elytra with small white spots arranged in two interrupted bands................................	**9. clavatus.**
11.	Elytra rounded on the sides........	**10. crassulus.**
	" nearly parallel, form elongate...............	**11. longulus.**
12.	Prothorax not channeled, occiput clothed with white scales..	**12. nuchalis.**
	Prothorax channeled, head uniform brown........	**13. pectoralis.**

1. **A. nobilis**, n. sp.

Black, coarsely punctured, with thick, erect brown scales, which when viewed in certain directions seem like short, obtuse bristles. Beak shining, naked, punctured; head densely clothed with small pale scales, frontal fovea large. Prothorax as long as wide, much rounded on the sides, narrowed before and behind; punctures very deep, disc convex with a faint trace of a median carina. Elytra with rows of deep, large, but rather distant oval punctures; interspaces very convex, except the two outer ones: there is a single marginal point behind the humeral angle; the white markings are conspicuous, of snow-white scales, as follows: a spot on the fifth, sixth and seventh interspaces near the base, connected with two small spots on the fourth, forming a sub-humeral blotch; a band behind the middle, composed of spots on the first to the fourth interspace; and many small spots irregularly disposed, formed of three or four white scales. Legs annulated with brown and pale scales. Ventral segments with a row of lateral spots of pale scales. Length 7.8 mm.; .31 inch.

Texas; Messrs. Boll and Belfrage; three specimens. Mr. Ulke has a species from Florida similar to this, but stouter, with the sides of the elytra angulated near the base.

2. **A. basalis**, n. sp.

Similar to the preceding, but smaller and less robust. Beak more strongly punctured, carinate; head covered with pale scales, extending half way upon the beak, front channeled. Prothorax with small, scattered spots of pale scales. Elytra with the suture, a transverse band at the base, enclosing a black humeral spot, and some scattered small spots of pale brown scales; striæ composed of more approximate quadrate punctures, interspaces except the two outer ones convex. Body beneath more coarsely and deeply punctured than in *A. nobilis*, and thinly clothed with pale scales, rather more dense at the sides of the ventral segments. Legs annulated. Length 5.5 mm.; .22 inch.

One specimen collected by me in Colorado.

Digitized by Google

3. **A. porosus**, n. sp.

Similar in form to *A. basalis*, but larger; the beak is longer, and distinctly carinate; head covered with pale scales extending upon the beak; front channeled. Prothorax very deeply and densely punctured, finely carinate, irregularly clothed with brown scales. Elytra with rows of approximate large quadrate punctures, the intervals between which are nearly as high as the interspaces; second, fourth and sixth interspaces wider and more convéx, tesselated with spots of pale and dark brown; rest of the surface with scattered pale scales. Beneath coarsely and deeply punctured, thinly clothed with pale scales; legs annulated. Length 8 mm.; .32 inch.

Two specimens from Colorado; one collected by myself, the other in the cabinet of Dr. Horn.

4. **A. turbidus**, n. sp.

Rather narrow, black, densely clothed with thick dirt colored scales. Beak naked, punctured, subcarinate; head densely clothed with small scales, front channeled. Prothorax deeply and densely punctured as usual, not carinate, longer than wide, narrower in front than at base; sides broadly rounded. Elytra with rows of large, approximate, quadrate punctures, interspaces wide, somewhat convex; markings indistinct, but when present, consisting of an irregular basal fascia, and an undulated one behind the middle, very much as in *A. basalis*. Under surface deeply and coarsely punctured, thinly clothed with dirt colored scales. Length 7 mm.; .28 inch.

Arizona, Dr. Horn; several specimens. Related to *A. basalis*, but narrower, and with differently colored scales.

5. **A. clathratus**, n. sp.

Narrow, black, clothed with dirt colored scales. Beak rather stouter, punctured and subcarinate, head covered with small scales extending upon the beak, front channeled. Prothorax as in the preceding. Elytra with rows of large, approximate, quadrate punctures, which almost overlap, so that the interspaces are very narrow and indistinct. Body beneath coarsely and deeply punctured, thinly clothed with dirt colored scales. Length 4.7 mm.; .19 inch.

One specimen found by me in Colorado. Differs from the preceding by the larger punctures of the elytra, and narrower interspaces.

6. **A. carinatus**, n. sp.

Black, densely covered with thick scales, of dark brown color; mottled (but not tesselate) with pale scales upon the elytra, forming indistinct transverse lines; an oblique zigzag band about the middle is the most conspicuous of these markings. Prothorax as long as wide, sides strongly rounded, widest about the middle, much narrowed in front, broadly but not deeply constricted near the tip; disc coarsely and densely punctured, very distinctly carinate. Elytra at the widest part scarcely wider than the middle of the prothorax; oval, sides rounded, basal angles not prominent; striæ composed of quadrate large punctures; interspaces distinctly defined: third,

Digitized by Google

fifth and eighth somewhat more convex; each interspace with a row of very short, thick, inconspicuous bristles. Length 4 mm.; .16 inch.

One specimen, Illinois. Easily known by the strongly carinate prothorax.

7. **A. granosus**, n. sp.

Rather stout, black, densely clothed with dark brown scales. Prothorax as wide as long, rounded on the sides, scarcely wider at the middle than at the base, much narrowed in front, and broadly constricted; disc densely punctured, strongly carinate, marked with a short, transverse white line at the middle, interrupted at the dorsal line; the parts of this transverse line are nearly joined by a short, posterior dorsal white line, forming a T-shaped mark; there are also a few inconspicuous dots of white pubescence. Elytra ovate, distinctly wider at the middle than the prothorax, truncate at base, with the basal angles well defined; striæ composed of large, shallow, quadrate punctures; interspaces well defined, the alternate ones more elevated, and interrupted so as to become tuberculate; the brown scales are mottled with dots of pale scales, of which the most conspicuous form a narrow, irregular, transverse band about the middle; the bristles are very short, but more distinct than in the preceding species. Length 3.4 mm.; .13 inch.

Florida, at Enterprise, Haulover and Indian River; Messrs. Hubbard and Schwarz.

8. **A. sordidus**, n. sp.

Robust, black, clothed with a dirt colored crust concealing the sculpture, with intermixed slender, curved bristles pointing backwards; beak naked and punctured towards the tip, not carinate; front not channeled. Prothorax a little wider than long, rounded on the sides, obsoletely channeled. Elytra striate, with the interspaces slightly convex, with rows of reclinate bristles. Length 2.5 mm.; .10 inch.

Texas, Belfrage; one specimen.

9. **A. clavatus** Say, Curc. 29; ed. Lec. i, 297: Boh., Sch. Curc. iv, 354.

Enterprise, Florida; Messrs. Hubbard and Schwarz; found also in Illinois. This small species is thickly clothed with brown scales, and but slightly varied in color; there are, however, two interrupted bands composed of small white spots on the elytra; the striæ are composed of large, quadrate punctures; the interspaces are wide, slightly convex and furnished with rows of long, clavate bristles. The prothorax is very coarsely punctured, not carinate, and the bristles are a little shorter than upon the elytra. Length 2.5 mm.; .10 inch.

The female is stouter than the male, with the prothorax not much wider at the middle, and the elytra much more rounded on the sides.

I have received from Col. Motschulsky a specimen from New Orleans, which seems quite similar, except that the punctures of the elytral striæ are so large that the interspaces become very narrow. I am disposed to believe that this appearance is owing to partial abrasion of the scales. If, however, with a larger series of specimens, it should be found to be really distinct, the name *A. scabrosus* Motsch. will be retained for it.

Digitized by Google

10. **A. crassulus**, n. sp.

Rather robust, black, densely clothed with dark brown scales, and erect thick bristles, which are shorter upon the prothorax. The latter is about as long as wide, rounded on the sides, slightly wider at the middle, much narrowed in front and broadly constricted; densely punctured, with a few pale brown scales at the sides, and a small spot at the middle of the base. Elytra as in *A. clavatus;* brown towards the base, and with an irregular, broad, yellowish brown band behind, occupying the posterior third of the elytra. Legs clothed with yellow brown scales. Length 2.5 mm.; .10 inch.

Haulover, Florida; Messrs. Hubbard and Schwarz.

11. **A. longulus**, n. sp.

This species is colored exactly like the preceding, but is of very different form, and the bristles of the elytra are longer. The prothorax is a little longer than wide, and is distinctly wider at the middle than at the base. The elytra are oblong, nearly parallel on the sides, suddenly wider at base than the prothorax, with the humeral angles prominent and rounded; less obliquely narrowed, and more broadly rounded behind than usual. Length 2.5 mm.; .10 inch.

Haulover, Florida; Messrs. Hubbard and Schwarz. I should consider this as the ♂ of the preceding species, if the bristles of the elytra were not so much longer. The form of the elytra is quite different from any other *Acalles* known to me, and resembles that seen in certain small *Cryptorhynchi.* The longitudinal distance between the middle and hind coxæ is also greater than in the other *Acalles*, and fully as great as in *C. minutissimus;* but the metathoracic episterna are not visible, while in the insect last named they are narrow, and very apparent.

12. **A. nuchalis**, n. sp.

Very robust, clothed with brown scales, dark and paler intermixed. Beak strongly punctured and sulcate, finely carinate, occiput clothed with pale scales. Prothorax nearly twice as wide as long, rounded on the sides, scarcely wider at the middle, then rapidly narrowed to the tip, but not constricted: coarsely and densely punctured, with three very indistinct pale brown lines; a slight trace of a narrow median smooth line. Elytra ovate, truncate at base, much rounded on the sides, obliquely narrowed behind; basal angles obtuse, not prominent; striæ composed of large, quadrate punctures; interspaces wide, slightly convex, each with a row of moderately long, pale, clavate bristles; the scales of the posterior third are more mixed with yellowish brown, and are limited in front by an angulated line of pale scales extending to the fifth stria. Beneath nearly black, with scattered pale scales; mesosternum less deeply emarginate than in the preceding species, but more strongly than in *A. pectoralis.* Metasternum as short as in the other species, but with the episterna narrow and distinct. Length 4 mm.; .16 inch.

Capron, Florida; Messrs. Hubbard and Schwarz; one specimen. An anomalous species, which with the form of *Acalles* combines the distinct

Digitized by Google

metathoracic side pieces of *Cryptorhynchus*. The last joint of the tarsi is rather longer, and the claws somewhat larger than in the other species of *Acalles;* the beak is also more slender and differently sculptured. A revision of the tribe with careful study of the exotic forms will probably show the propriety of placing this species as a distinct genus.

13. **A. pectoralis**, n sp.

Robust, black, covered with depressed scales of dark brown color, variegated with pale on the elytra, forming narrow, undulated bands, and on the prothorax indistinct stripes; intermixed bristles stout, short, erect. Antennæ testaceous. Beak coarsely punctured, finely carinate, scaly, tip naked; head scaly like the beak, front not impressed. Prothorax wider than long, convex, much rounded on the sides, distinctly constricted in front, channeled. Elytra much rounded on the sides, striæ deep and fine, interspaces wide, slightly convex. Body beneath densely but less coarsely punctured, clothed with yellowish brown scales; mesosternum very broadly emarginate. Legs annulated. Length 3 mm ; .12 inch.

One specimen, Illinois. Quite distinct from all the others by the less emarginate mesosternum, and the depressed scales of the prothorax and elytra. It is possible that these differences should be considered as generic, but I am unwilling to so regard them without a careful study of foreign species.

EURHOPTUS n. g.

I have separated as a distinct genus a small pyriform, robust species, not scaly, but thinly clothed with reclinate bristles, in which the metasternum is very short as in *Acalles*, but which differs essentially by the club of the antennæ ; this is stouter, less elongate, and annulated only near the tip; the funicle is 7-jointed; the second joint a little longer than third, 3–7 equal, short, closely united. Beak stout, as long as the prothorax. Mesosternum horizontal, emargination broad, with acute edge. First ventral segment longer than metasternum, with a deep, polished triangular impression; intercoxal process triangular; second segment shorter than third and fourth united; fifth as long as the three preceding united. Thighs not toothed, tibiæ slender, straight, mucronate at tip; tarsi with third joint broadly dilated; fourth small with very small, approximate claws. Elytra connate; scutellum not visible.

1. **Eu. pyriformis**, n. sp.

Robust, pear-shaped, convex, dull black, thinly clothed with pale, reclinate curved bristles. Beak stout, rather depressed, finely punctured, naked at tip, subcarinate; eyes small, depressed, front not impressed; antennæ brown. Prothorax not wider than long, narrowed from the base, sides straight, base nearly straight, disc densely and coarsely punctured, feebly transversely impressed at a distance from the tip. Elytra fitting closely to the prothorax, strongly rounded on the sides; striæ composed of very large, rather distant foveæ; interspaces near the suture somewhat convex. Length less than 2.5 mm.; .10 inch.

Digitized by Google

Three specimens from Illinois. The ventral surface is nearly smooth; the fifth segment punctulate and broadly concave.

MICROMASTUS n. g.

I have established this genus upon the Californian *Cryptorhynchus gracilis* Boh., Eugenies Resa, Col. 140.

It is related by the short metasternum and indistinct side pieces to *Acalles*, but differs by the mesosternum being small, and but very slightly prominent, though the concavity of the front perpendicular surface shows that the tip of the beak rests against it in repose; the pectoral canal is deep, though not sharply limited behind the front coxæ, which are nearly contiguous. The body is elongate; the elytra wider than the prothorax, elongate-oval, sharply margined at the base, with the humeri not prominent. The prothorax is longer than wide, broadly rounded on the sides, truncate in front, with the postocular lobes nearly obsolete, and fringed with vibrissæ. Head convex, eyes small, coarsely granulated; beak as long as the prothorax, not stout, slightly curved, rather depressed at tip; antennæ inserted about one-fourth from tip, slender; club pubescent, not very distinctly annulated on the outer half. Legs moderate, thighs scarcely clavate, feebly toothed beneath; tibiæ (front pair) sinuate on inner side; tarsi with third joint broad, bilobed, fourth as long as the others united; claws large, divergent, simple. Ventral sutures straight; second and fifth segments equal to third and fourth united.

1. **M. gracilis** (Boh.), l. c. sup. (*Cryptorhynchus*).

Elongate, brown, thinly clothed with white pubescence, beak punctured and striate towards the base, with a narrow, smooth dorsal line. Prothorax deeply and coarsely punctured. Elytra with rows of approximate, quadrate punctures; interspaces narrow, convex; behind the middle on each side are two spots of white pubescence; the hinder one extending from the first to the fifth stria, the anterior one from the fourth to the sixth. Beneath coarsely and densely punctured. Length 3.6 mm.; .15 inch.

San Francisco; collected by Mr. Henry Edwards; the specimen is very imperfect.

PSEUDOMUS Sch.

In this genus the metasternum, though short and without distinct episterna is longer than in *Acalles*, and nearly or quite as long as the first ventral; the mesosternum is horizontal, continuing the plane of the metasternum, with which it is closely united; the emargination is deep, extending to about the middle of the coxæ. The second ventral is not longer than the third or fourth separately; the fifth is a little longer. The thighs are armed with a tooth in some species, unarmed in others; the tibiæ are straight, slightly mucronate at tip; tarsi with third joint broadly dilated; fourth joint of usual size; claws simple, divergent. The beak is more slender than in *Acalles*, and the general outline is that of *Chalcodermus*.

1. **Ps. truncatus**, n. sp.

Dark brown, thinly clothed with small, brown scales; beak slender, as long

Digitized by Google

as the prothorax, nearly smooth at tip, punctured and feebly striate at base; head punctured. Prothorax wider than long, narrowed from the base forwards, sides nearly straight, convex; not densely punctured, with a median stripe and a small spot each side, smooth. Elytra with striæ composed of large, distant punctures, with an irregular basal fascia, and a large, common spot behind the middle white; the latter prolonged backwards along the suture nearly to the tip. Beneath thinly clothed with yellowish scales; ventral segments 2–4 nearly smooth; fifth with a few large punctures; thighs obtusely toothed. Length 4.6 mm.; .18 inch.

South Carolina and Georgia; Dr. Zimmermann. I have adopted the specific name given by Dejean in his Catalogue.

2. **Ps. sedentarius** (Say), Curc. 30 (*Cleogonus*); ed. Lec. i, 298; Boh., Sch. Curc. iv, 267.

Florida; unknown to me. Differs from the preceding by the unarmed thighs, and differently formed posterior elytral spot.

TYLODERMA Say. (1831.)

Analcis Sch. (1837.)

In this genus the beak is rather short and stout, and the mesosternum, while very prominent, and forming a sharp edge which limits the pectoral groove, is very feebly emarginate, resembling in this respect *Acalles pectoralis*. From *Acalles* it differs evidently, besides many other characters, by the more elongate form; the very distinct postocular lobes, the prothorax prominent and rounded in front; the longer metasternum, with distinct, though narrow side pieces. From *Cryptorhynchus* it is distinguished by the form of body, the feebly emarginate mesosternum, and the 6-jointed funiculus, as well as by the stouter beak, with more suddenly declivous antennal grooves. The first ventral suture is nearly obliterated.

The species fall naturally into two divisions already indicated by Dr. Horn, Proc. Am. Ent. Soc. 1873, 467; the first contains the type of *Tyloderma*, the second that of *Analcis;* I have, therefore, restored the former name to the conjoined genus.

Division I.

In the first division the color is not metallic; the pubescence is in distinct spots, and sometimes scaly; the abdomen is coarsely punctured, and the punctures of the elytra are large. These species resemble in appearance *Mæmactes*, but differ very greatly in structural characters.

I have nothing to add to the characters of the four species of this group, as given by Dr. Horn, but to say that *T. foveolatum* varies greatly in size, some specimens being no larger than *T. variegatum*, from which it is at once distinguished by the foveate rather than punctate prothorax.

1. **T. morbillosum**. *Analcis morb.* Lec. Pac. R. R. Expl. insects, p. 58; Horn, Proc. Am. Phil. Soc. 1873, 467.

One specimen, San Francisco, California.

Digitized by Google

2. **T. foveolatum** Say, Curc. 19; ed. Lec. i, 284. *Cryptorhynchus fov.* Germ., Sch. Curc. iv, 140: *Analcis fov.* Horn, loc. cit. 468.

New York to Texas.

3. **T. variegatus**. *Analcis var.* Horn, Pr. Am. Phil. Soc. 1873, 468.

Southern and Western States.

4. **T. fragariæ**. *Analcis frag.* Riley, Report on Insects of Missouri, iii, 42, fig. 14: Horn, loc. cit. 469.

Illinois and Missouri, infesting strawberry vines.

5. **T. longum**, n. sp.

Elongate, black, densely clothed with small black scales, which make the surface opaque; mottled irregularly with white on the elytra. Beak strongly punctured. Prothorax longer than wide, widest at the middle, where the sides are strongly rounded, much narrowed in front, feebly narrowed behind, feebly constricted near the tip, which is broadly rounded; coarsely and confluently punctured, very finely, almost imperceptibly carinate. Elytra scarcely wider than the prothorax, cylindrical, elongate, base truncate, humeri rectangular rounded; striæ deep, composed of large approximate punctures, interspaces narrow, the outer ones convex. Beneath coarsely punctured, somewhat shining; thighs obsoletely toothed. Length 3.7 mm.; .15 inch.

One specimen, Haulover, Florida; Messrs. Hubbard and Schwarz. Very distinct by the more elongate form, and denser sculpture; the beak is also longer and more slender, but the mesosternum, as in the other species, is only feebly emarginate.

Division II.

In this division the color is metallic, the surface glabrous; the sculpture fine, or even indistinct, and the abdomen smooth. or partly so.

6. **T. æreum**. *Bagous æreus* Say, Curc. 29; ed. Lec. i, 297; *Analcis æreus* Rosensch., Sch. Curc. iv. 279; Horn, Proc. Am. Phil. Soc. 1873, 460.

The specimens of *T. æreum* as observed by Dr. Horn vary greatly in size and sculpture; in some the prothorax is nearly smooth, in others it is sparsely and coarsely punctured on the flanks; in others again the disc is in addition distinctly punctured.

With an increased series of specimens I observe that in two individuals the disc of the prothorax is deeply and sparsely punctured, and the flanks coarsely punctured; the ventral segments 1–2 are very distantly and finely punctured; the third and fourth are deeply, transversely impressed, and the front or convex part is marked with a series of fine punctures; the fifth joint is sparsely but deeply punctured. Length 3.6 mm.; .14 inch.

Middle and Western States.

In specimens from South Carolina and Florida, of large size, the prothorax even on the flanks is smooth; the punctures of the elytra less regular and larger, the surface somewhat rugose, and the ventral segments are smooth, the fifth is transversely concave near the tip; the metasternum is

Digitized by Google

also smooth, as is not the case in any other specimens in my collection. Length 4.5 mm.; .18 inch.

Two very small specimens from Georgia have the disc and flanks of the prothorax nearly smooth, and the ventral segments also smooth, except the fifth, which is very finely punctured and surrounded behind by a marginal line, but not transversely impressed; the legs are brown. Length 2.3 mm.; .09 inch.

I believe that these forms indicate species which the amount of material at my disposal does not permit me to distinctly define, and which I shall therefore abstain from naming. Careful observation of their habits and collection in quantity, when possible, will enable the correctness of this view to be tested in future.

One specimen from Texas, sent by Mr. Belfrage, is, however, so different as to require specific recognition.

7. **T. baridium**, n. sp.

Dull black, with a bronze tinge; beak strongly punctured, front not channeled, transverse impression feeble; head sparsely, finely punctured. Prothorax deeply but not densely punctured, not longer than wide, sides parallel behind, obliquely narrowed in front of the middle, scarcely constricted at tip. Elytra at base very little wider than the prothorax, humeri not prominent, slightly wider for a very short distance, then gradually narrowed to the tip; punctures of the rows distant, obsolete behind, interspaces very finely and sparsely punctulate, with scarcely perceptible white hairs in these punctulations, and in the punctures of the rows. Mesosternum and metasternum coarsely and sparsely punctured; ventral segments sparsely but gradually more deeply punctured; fifth with a rounded impression. Length 4 mm.; .16 inch.

PHYRDENUS n. g.

The form is precisely that of *Conotrachelus anaglypticus*, but the pectoral canal is deep and terminates in the mesosternum, which is excavated for almost its whole length, as in *Cryptorhynchus;* the claws are broadly appendiculate at base.

The beak is as long as the prothorax, slightly compressed, gibbous and suddenly separated from the front at base; the antennal grooves are oblique, as in *Conotrachelus;* the antennæ inserted one-fourth from the tip, rather slender, funicle 7-jointed; club elongate-oval, annulated. Prothorax with very large, postocular lobes, concealing the eyes in great part in repose. Eyes coarsely granulated; large, distant above. Side pieces of metathorax moderately wide, distinct; ventral sutures straight; second and fifth segments a little longer than the third and fourth separately. Legs rather slender, thighs feebly clavate, not toothed; tibiæ bent at the base, slender, feebly mucronate at tip; tarsi with third joint bilobed; fourth long with divergent, appendiculate claws.

1. **P. undatus**, n. sp.

Short and stout, blackish, densely clothed with very small scales forming a dense crust, of a pale brown color, varied with darker on the prothorax.

Digitized by Google

base and tip of the elytra; small, erect bristles are intermixed, forming tufts on the prothorax, and rows on the elytra. Prothorax as wide as long, sides parallel for two-thirds the length, strongly narrowed in front and deeply constricted; disc uneven, deeply and broadly channeled, with four conspicuous tufts of black bristles. Elytra at base nearly twice as wide as prothorax; humeri prominent, rounded; striæ not very distinct; third, fifth and seventh interspaces slightly elevated; the base and tip are dark brown, with an intermediate, very broad, slightly variegated band of pale brown; there is also a short, pale line at the base of the third interspace. Beneath densely punctured; punctures of first ventral segment coarser. Length 4.6 mm.; .18 inch.

Missouri, (Schuster); Georgia, Texas, (Belfrage). This species differs remarkably from all others known to me by the head being convex behind, and deeply concave between the eyes, so that the base of the beak appears gibbous. Judging from a MS. drawing of my father, this is *Cryptorhynchus undatus* ‡ Dej. Cat.

CRYPTORHYNCHUS Ill.

The species are numerous, and as very properly suggested by Lacordaire need subdivision into several genera. The peculiar modifications of structure noted by him are not represented in our fauna, and the species mentioned below seem to agree in all characters of importance. They may be divided into groups, commencing with those species which more nearly resemble in form *Conotrachelus*.

A. Antennæ slender, second joint of funicle as long as the first; 3–7 diminishing gradually in length, club indistinctly annulated.

a. Elytra suddenly wider than prothorax at base; prothorax carinate.

* Thighs straight beneath .... **Sp. 1-3.**

** Thighs sinuate near the tip.......................... **Sp. 4.**

b. Elytra but little wider at base than the prothorax:

* Prothorax strongly constricted at tip.................. **Sp. 5-8.**

** Prothorax carinate, feebly constricted at tip............ **Sp. 9.**

B. Antennæ stouter, funicle with joints 2–7 equal in length, gradually broader, club very distinctly annulated..... **Sp. 10-11.**

Division A—a*.

The species of this division bear a general resemblance to *Conotrachelus* in consequence of the elytra being suddenly wider than the prothorax, and the humeral angles prominent, rectangular and rounded; the sides gradually taper behind. The prothorax is strongly carinate, gradually narrowed from the base forwards, strongly constricted near the tip, with not very well-marked postocular lobes. The beak is slender, longer than the prothorax, curved, cylindrical, carinate, and striate at base. The antennæ are elongate, the funicle is slender, with the second joint as long as the first, and the following gradually diminish in length and

Digitized by Google

become more rounded; the club is scarcely annulated. The legs are slender, the thighs not clavate, with a feeble indication of two small distant teeth, which become evanescent in the smaller species. The tibiæ are straight, with a sudden bend, and a distinct angle in some species on the outer edge near the knee; the third tarsal joint is broadly bilobed, and the fourth is as long as the first, rather clavate, with moderate sized divergent claws.

The species may be tabulated as follows:

Black, with an oblique white spot on each elytron; tibiæ angulated at base...............................	2.
Brown, variegated; tibiæ not angulated at base.........	3
2. Larger, thighs feebly bidentate......................	1. **parochus.**
Small, thighs not toothed.............	2. **bisignatus.**
3. Prothorax and elytra with bunches of black bristles...	3. **fuscatus.**

1. **C. parochus** Say, Curc. 19; ed. Lec. i, 285; *Curculio parochus* Herbst, Käfer, vii, 55; tab. 99, fig. 5.

Middle and Western States. Closely resembles the next species, but is readily distinguished by the greater size (6–6.5 mm.; .24–.26 inch). The two femoral teeth are small and distant.

2. **C. bisignatus** Say, Curc. 19; ed. Lec. i, 284; *C. luctuosus* Boh., Sch. Curc. iv, 146; ibid. viii, 1, 348; *C. misellus* Boh., ibid. iv, 120, (fide Boheman).

Middle, Southern and Western States, to Texas. If the locality of the synonym last cited be correct, it is also found in Brazil. The thighs are sometimes entirely unarmed, sometimes very obsoletely bidenticulate. Length 3.5 mm.; .14 inch; it does not seem to vary in size, but the white mark of the elytra is sometimes very indistinct.

C. obliquefasciatus Boh., Sch. Curc. viii, 1, 349, is merely a more distinctly marked variety in which the oblique spot extends from the seventh to the second stria, becoming a band, and the scattered white dots are more conspicuous. One specimen is only 2.5 mm.; .10 inch long.

I have three specimens from the Middle States in which the upper surface is clothed with brown scales, and the elytral spots are more distinct; the humeri seem less prominent, and the form more elongate. It seems to be *C. pumilus* Boh., Sch. Curc. iv, 122. It is probably a distinct species, but I can find no other characters upon which to separate it, than those I have mentioned.

3. **C. fuscatus**, n. sp.

Blackish brown, clothed with pale and dark-brown scales, and bunches of erect blackish bristles. Beak moderately stout, as long as the prothorax, carinate, striate and coarsely punctured at base, then naked and more finely punctured; antennæ inserted nearly at the middle of the beak, slender, club pubescent, indistinctly annulate; head punctured, vertex very finely carinate. Prothorax as wide as long, strongly narrowed from the base, rounded on the sides, constricted in front, deeply and densely punc-

Digitized by Google

tured, carinate; disc with three conspicuous tufts of bristles, and two smaller ones near the front margin; others scattered singly; scales brown, with three narrow indistinct lines of paler; base squarely truncate each side, prolonged into a distinct angle at the scutellum, which is black. Elytra one-third wider at base than the prothorax, humeri rounded, prominent, sides not dilated, but parallel, and then gradually narrowed behind, clothed mostly with pale-brown scales, darker at the base and tip, and with a broad middle band sometimes indistinct; striæ fine, punctured, third, fifth and seventh interspaces more elevated; the third and fifth appear interrupted on account of crests of erect blackish bristles; of these there are three long ones on the third and three or four small ones on the fifth; also a few small bunches on the second interspace. Beneath clothed with pale-brown scales, deeply and densely punctured; thighs slender, not, or obsoletely toothed; tibiæ straight, not angulated at base as in *C. parochus* and *bisignatus*. Length 5.5 mm.; .22 inch.

Southern and Western States. So far as the meagre description given by Say goes, this species agrees well with his *C. obliquus*, but as Boheman and Say agree in stating that that name belongs to the species called by the former *C. umbrosus*, I do not feel at liberty to apply it to the present one, for which I have adopted the Catalogue name of Dejean. If our fauna had more representatives of this genus, I would separate this as a distinct division, differing from the preceding, not only by the tibiæ and stouter beak, but by the ninth elytral interspace being not elevated, and by the post-ocular prothoracic lobes being more prominent.

Division A—a**.

The single species representing this division in our fauna is of rather large size, more elongate, and less *Conotrachelus*-like than the species of the preceding division, from which it differs chiefly by the thighs being deeply sinuate beneath near the outer end, and by the two denticles being near together. The beak is stouter than in *C. parochus*, but hardly more so than in *C. fuscatus*, carinate and striate at base; the antennæ are inserted about two-fifths from the end; the funicle is slender; second joint as long as the first, the others gradually shorter; club not perceptibly annulated. Prothorax rounded on the sides, strongly narrowed in front, and feebly constricted, postocular lobes not very distinct; base squarely truncate each side, prolonged into a distinct angle at the scutellum. Elytra one-third wider at base than the prothorax, nearly parallel on the sides, then narrowed to the tip, humeri rounded, less prominent than in the first division; striæ composed of large punctures; third, fifth, and seventh interspaces slightly elevated. The ventral segments are very coarsely punctured, and the fifth in the only perfect specimen before me has a very deep circular impression, probably sexual, and indicating the ♂. The thighs are slender, with two small approximate teeth, then deeply sinuate near the tip; the tibiæ are straight, and rather strongly mucronate at tip, suddenly bent at base near the knee; tarsi as in the first division.

Digitized by Google

4. **C. obliquus** Say, Curc. 28; ed. Lec. i, 296 (?); *C. umbrosus* Boh., Sch. Curc. iv, 116.

Middle States; our largest species. I only restore the name of Say to this insect in deference to the statement of both Say and Boheman that the two names represent the same species. My own preference would be to ignore this assertion altogether, to call No. 3 *C. obliquus*, and the present one *umbrosus*. It seems to me to be a case of confusion of two species by Mr. Say, similar to that recorded in the genus *Calosoma;* when by not observing very obvious differences, he sent to Dejean under the name of *C. calidum*, a very distinct species afterwards described by the latter as *C. Sayi*.

A—b*.

The species representing this division in our fauna are of an elongate-oval form, with the elytra at base but little wider than the prothorax; the humeral angles are obtusely rounded not very prominent; the sides are parallel, then obliquely narrowed to the tip. The prothorax is wider than long, much rounded on the sides, narrowed in front of the middle, and very strongly constricted, postocular lobes broad; the disc is carinate, the base broadly emarginate each side, with the angle in front of the scutellum very small, not prominent. Scutellum small, white. The beak is as long as the prothorax, rather stout, somewhat flattened; the antennæ are inserted about the middle of the beak; funicle slender, second joint as long as the first; the others gradually diminishing, club elongate-oval, annulated. Thighs slightly clavate, armed with a single tooth, which is nearly obsolete in the smaller species; tibiæ nearly straight; tarsi as in the preceding divisions.

The body is densely clothed with small, depressed scales, with very short, stout bristles intermixed, which in *C. apiculatus* become spines.

Thorax with an elongate median pale spot...........	5. **obtentus**.
" " sides broadly pale, disc black....	6. **fallax**.
Smaller, elytra with pale transverse band...........	7. **minutissimus**.
Alternate spaces of elytra with a row of spines.	8. **apiculatus**.

5. **C. obtentus**. *Curculio obt.* Herbst, Käfer, vii, 38, pl. 99, fig. 2. *Cryptorhynchus ypsilon* Boh., Sch. Curc. iv, 100.

Middle and Southern States; the specimen described by Herbst was evidently badly preserved, and the median pale line of the prothorax had disappeared; normally this line is wider at the middle, of a narrow lozenge-shape, and includes a dark central spot. When the front part is abraded it assumes a Y-shape. The third and fifth elytral interspaces are strongly elevated; the femoral tooth is quite distinct. Length 5.3–7.5 mm.; .16–.3 inch.

6. **C. fallax**, n. sp.

Elongate-oval, black, covered with pale brown scales, with intermixed short bristles; disc of prothorax and large common triangular spot on elytra black. Beak strongly punctured, as long as the prothorax, flattened, scarce-

Digitized by Google

ly subcarinate, with a smooth narrow median line; antennæ brown with slender funicle; club oval-acuminate, annulated. Prothorax wider than long, narrowed gradually in front, broadly rounded on the sides, strongly constricted near the tip, deeply and densely punctured; very finely carinate behind; base rather strongly bisinuate, medial angle small, distinct; scutellum very small, covered with white scales. Elytra very little wider than prothorax at base, humeri rectangular, slightly rounded, not prominent, sides parallel, then obliquely narrowed to the tip; striæ composed of large, subquadrate punctures, interspaces somewhat convex; third and fifth more elevated. Legs slender, thighs with one very small tooth; tibiæ straight, outer edge angulated near the base; tarsi as in the preceding species. Length 4.3 mm.; .17 inch.

Illinois to Texas. The size of the thoracic and elytral dark space is somewhat variable; it may, however, be stated in general terms, that it occupies nearly the whole of the base of the prothorax, and narrows to the apex, of which it covers the middle third; it extends on the elytra from the humeri obliquely backwards, ending on the suture about the middle; in other specimens there is a brown, irregular band behind it and connected with it, but this is probably produced by an abrasion of the scales. The body beneath is densely clothed with dirt colored scales.

I have adopted the name given in Dejean's Catalogue.

7. **C. minutissimus**, n. sp.

Oval, moderately elongate, brown, varied with blackish spots, clothed with black, brown and pale scales; the latter forming an elongate basal spot on the prothorax, and a transverse band behind the middle of the elytra, angulated at the suture; short, stout, erect bristles are intermixed. Beak stout, flattened, punctured, naked from the tip to the middle (antennæ not seen). Prothorax wider than long, narrowed gradually in front, moderately rounded on the sides, strongly constricted near the tip, not carinate, postocular lobes nearly obsolete; base very feebly bisinuate, median angle very obtuse, indistinct. Scutellum hardly visible. Elytra very little wider than prothorax at base; humeri rounded, not prominent; sides slightly rounded, then obliquely narrowed to the tip; striæ composed of large punctures, which are concealed by the scales, so that the striæ appear to be fine and impressed. Thighs unarmed; tibiæ straight; outer edge angulated near the base; tarsi as in the preceding species. Body beneath deeply and densely punctured; clothed with dirt colored scales. Length 2.5 mm.; .10 inch.

Virginia to Louisiana. I have adopted the Catalogue name of Dejean for this very pretty little species. Col. Motschulsky gave me two individuals as his *Acalles pictus* and *fasciculatus*, but I believe that the names were never published. In generic characters this species differs greatly from *Acalles*, though somewhat resembling *A. clavatus* in size and form.

8. **C. apiculatus** Gyll., Sch. Curc. iv, 121.

Florida; Messrs. Hubbard and Schwarz. Very distinct by the prothorax suddenly and strongly constricted near the tip, and by the erect, stout

Digitized by Google

bristles, or spines which are sparsely placed upon the prothorax, and upon the alternate interspaces of the elytra. Length 3.7 mm.; .15 inch.

A—b**.

The body is elongate-oval, as in the last division, from which this differs chiefly by the prothorax being feebly constricted near the tip.

The beak is more slender towards the tip, and not flattened, about as long as the prothorax and moderately curved; the antennæ are less slender, though the second joint of the funicle is as long as the first; the club is oval, annulated. Prothorax wider than long, narrowed in front from the base, moderately rounded on the sides, feebly constricted near the tip, with distinct postocular lobes; disc strongly carinate; base truncate each side: middle lobe acute, very distinct; scutellum indistinct. Elytra very little wider than the prothorax at base; humeri rounded, not very prominent; sides subsinuate, then narrowed to the tip; alternate intervals feebly convex, with tufts of erect bristles. Thighs sinuate beneath near the tip, armed with two distinct teeth; tibiæ slightly curved; very distinctly mucronate; tarsi as in most of the other species.

9. **C. tristis**, n. sp.

Elongate-oval, densely clothed with dark gray scales, with intermixed short erect bristles, which on the elytra are arranged in tufts upon the alternate interspaces. Beak more slender at tip, punctured. Prothorax deeply and densely punctured, strongly carinate, formed as above described. Elytra indistinctly variegated on the ground color, tufts of bristles darker. Beneath clothed with dirt colored scales, densely punctured. Length 5 mm.; .20 inch.

Middle and Western States. I have adopted Dejean's name for this species.

B.

The species of this division differ from all those above mentioned by the elytra more oblong in form, and by the joints of the funicle of the antennæ 3–7 being equal in length, and gradually wider; the second joint is either nearly as long as the first (*oblongus*), or very distinctly shorter; the club is small, rounded-oval, distinctly annulated. The prothorax is rounded on the sides, a little wider than long, narrowed in front, not strongly constricted, with the postocular lobes feeble; the disc is not carinate. Scutellum variable; elytra wider at base than the prothorax, with the humeri rounded, not prominent, sides parallel, then obliquely rounded to the tip; interspaces somewhat convex, nearly equal. Legs slender, thighs armed with a distinct tooth in one species, which is obsolete in the other; tibiæ nearly straight.

Second joint of funicle scarcely shorter than first; body mottled with gray and brown scales............... **10. oblongus.**
Second joint of funicle much shorter than first; elytra with alternate interspaces tessellated.................. **11. ferratus.**

Digitized by Google

10. **C. oblongus**, n. sp.

Oblong elongate, black, thickly clothed with brown and gray scales irregularly intermixed; back of head, and some indistinct lines upon prothorax pale. Beak as long as prothorax, rather more slender than usual, naked, dark-brown, punctured. Antennæ brown; second joint of funicle nearly as long as the first, 3–7 equal in length, gradually broader and rounded. Prothorax wider than long, deeply and densely punctured, not carinate, narrowed from the base, rounded on the sides, moderately constricted near the tip, base each side truncate, median lobe distinct. Scutellum very distinct, clothed with brown scales. Elytra one-fourth wider than the prothorax, humeri rounded, not prominent; sides parallel, scarcely perceptibly sinuate, then obliquely rounded to the tip; striæ composed of approximate punctures, fifth with a narrow blackish spot behind the middle, interspaces convex, equal. Thighs with a distinct obtuse tooth, and front pair with an additional small denticle; beneath coarsely and densely punctured, thinly clothed with large, pale scales. Length 6 mm.; .23 inch.

Georgia and Texas, two specimens. There are no bristles intermixed with the scales.

11. **C. ferratus** Say, Curc. 28: ed. Lec. i. 296; Boh., Sch. Curc. iv. 143.

Middle, Southern and Western States. Easily known by the small size, stout funicle, and alternate elytral interspaces ornamented with pale spots. The scales are intermixed with very short bristles. Say has described the elytra as striate, without punctures, but the description of Boheman is quite correct; the striæ are as strongly punctured as is usual in the genus, and when the scales are removed, are seen to be quite deep, with convex interspaces. Length 3.2 mm.; .125 inch.

ZASCELIS n. g.

The species of this genus are rather elongate and depressed, coarsely sculptured, pubescent, and sometimes also scaly. The beak is long, slender, slightly curved, cylindrical, and extends almost to the metasternum. The antennæ vary with the species, the club being sericeous, elongate in one species, and scarcely annulated, while in the others it is oval and annulated. The ventral sutures are deep, and the first is slightly sinuate; the first ventral segment is longer than the second, which is equal to the third; fourth and fifth are also equal in length. The mesosternum is elongate, and deeply excavated almost to the base. The thighs are rather stout, armed beneath with a small tooth, tibiæ broad, compressed, with a row of teeth along the outer margin of the middle and hind pairs, which becomes indistinct in some species.

This genus seems to be allied to *Cnemargus* and *Enteles*, but differs (according to description) by the toothed tibiæ; this character is an extremely rare one in *Curculionidæ*, and I find it mentioned by Lacordaire only in one instance: in *Cnemidophorus* which is allied to *Magdalis*.

The species may be distinguished as follows:

Digitized by Google

A. Pubescence long, not mixed with scales:
  Tibiæ very coarsely toothed.................... **1. serripes.**

B. Pubescence shorter: tibiæ feebly toothed:
  Pubescence erect, intermixed with large scales.. **2. squamigera.**
  Pubescence prostrate, squamiform............. **3. irrorata.**

1. **Z. serripes,** n. sp.

Oblong oval, black, clothed with coarse, erect, brown hairs; beak densely punctured, substriate near the base, frontal puncture distinct; head punctured. Prothorax wider than long, narrowed in front from the middle, rounded on the sides, scarcely constricted at tip, which is nearly truncate, postocular lobes feeble; disc densely and coarsely punctured, obsoletely carinate. Scutellum very small. Elytra but little wider than the prothorax, truncate at base, rounded behind the humeri, which are closely applied to the base of the prothorax; striæ deep, coarsely and distinctly punctured, interspaces narrow convex, sparsely punctured. Beneath coarsely punctured, tibiæ with a fringe of marginal bristles, and 5–7 large, prominent teeth; front tibiæ obtusely bidentate near the tip; apical hook distinct. Length 6 mm.; .23 inch.

Cape San Lucas, Lower California; Mr. Xántus. The pubescence is very like that of *Gymnetron teter*, but rather coarser. The funicle of the antennæ is slender; joints 1–2 equal in length, club small, oval-acuminate and annulated.

2. **Z. squamigera,** n. sp.

Larger and of the same form as the preceding, with the punctures coarser; the pubescence shorter, and intermixed with oval yellowish scales. Beak densely punctured, not striate at base. Prothorax more rounded on the sides, slightly narrowed behind the middle, finely carinate; elytra with the interspaces slightly carinate. Tibiæ finely serrate. Length 7.7 mm.; .30 inch.

One male, Cape San Lucas; Mr. Xántus. The funicle of the antennæ is slender, the club elongate, scarcely annulated; this form of club is probably a sexual character.

3. **Z. irrorata,** n. sp.

Elongate, black, pubescence fine, sparse, prostrate, subsquamiform and collected in spots on the elytra. Beak densely punctured, substriate at base, frontal puncture distinct, head punctured. Prothorax not wider than long, sides parallel behind, rounded and obliquely narrowed before the middle, scarcely constricted at tip, densely and coarsely punctured, with a very narrow, smooth dorsal line. Elytra but little wider than the prothorax, rounded just behind the humeri, then nearly parallel on the sides; striæ composed of large approximate quadrate punctures, interspaces narrow, punctured. Thighs armed with a small tooth; middle and hind tibiæ feebly serrate, obtusely bidentate near the tip. Body beneath coarsely punctured, sparsely clothed with pale brown scale-like hairs. Length 5–6.5 mm.; .20–.25 inch.

Digitized by Google

California, Nevada, and Colorado. In the specimens I have seen, the funicle of the antennæ is less slender than in the two preceding species; the club is oval-acuminate, small, and feebly annulated. The legs are much less coarsely punctured than in the other two species.

COELOSTERNUS Sch.

In order to avoid unnecessary multiplication of genera in a series as yet so imperfectly systematized, I refer to this genus a single species from Lower California, which is allied to *Zascelis*, but has the beak stouter and less elongated, the funicle of the antennæ stouter, the club small, oval-acuminate, and annulated. The legs are stouter, the thighs armed with an acute tooth, the tibiæ compressed, not serrate, furnished on the outer margin with a row of stiff bristles from the middle to the tip, and and rather strongly unguiculate at the inner apical angle. The second ventral segment is a little longer than the third, but not very obviously so.

1. **C. hispidulus**, n. sp.

Elongate, black, clothed with short, erect brown hairs; head and beak densely punctured, the latter feebly carinate towards the base. Prothorax a little longer than wide, broadly and regularly rounded on the sides, more narrowed in front than at base, disc rather flattened, coarsely and densely punctured, with an obsolete smooth dorsal line. Elytra elongate-oval, a little wider than the prothorax, striæ wide, irregularly coarsely punctured, four inner interspaces on each narrow, elevated, the others indistinct. Body beneath and legs very coarsely punctured. Length 5.5 mm.; .215 inch.

One specimen, Cape San Lucas, Mr. Xántus. A little more elongate than *Zascelis irrorata*, and quite easily recognized by the characters above given. The eyes are widely separated, and in repose are almost concealed.

BAROPSIS n. g.

The single species for which I propose this generic name, agrees with the two preceding genera in most characters, but differs essentially in the first ventral suture being more distinctly sinuate, and nearly obliterated at the middle, and the second ventral segment as long as the two following united. The beak is nearly as stout as in *Tyloderma*, and the eyes are approximate above; the funicle of the antennæ is slender, 7-jointed, the second joint as long as the first; the following are shorter, but not much thickened; club small, oval-acuminate, annulated. Legs not very stout, thighs feebly clavate, armed with a small acute tooth; tibiæ moderately compressed, not as wide as in the two preceding genera, not toothed, terminal hook small; there is a fringe of hair on the outer margin towards the tip, as in *Cœlosternus*.

The general appearance is that of *Tyloderma*, but the sculpture resembles that of several species of *Baris*. It is closely related to the Mexican

Digitized by Google

Mamactes, but differs by the first ventral suture being sinuate, and less distinct at the middle.

1. **B. cribratus**, n. sp.

Black, rather shining, with very sparse and fine pubescence proceeding from the punctures. Beak as long as the prothorax, stout, not densely punctured, punctures becoming larger towards the base; head sparsely punctured. Prothorax oval, longer than wide, broadly rounded on the sides, a little narrower at tip than base, and scarcely constricted, rather flattened, very coarsely and not densely punctured. Elytra elongate-oval, humeri acute, slightly prominent forwards; striæ broad and deep, catenate with large quadrate punctures, interspaces as wide as the striæ, with a row of distinct distant punctures. Beneath very coarsely and distantly punctured, punctures of the 3–5th ventral segments smaller. Length 4 mm.; .16 inch.

Kansas and Texas; two specimens. A very distinct and easily recognized species.

Tribe XVI. ZYGOPINI.

The form of these insects is quite peculiar; the body is elongate, subrhomboidal, the first and second ventral segments long, the remaining ones short, rarely horizontal, as in the preceding genera, but forming an obliquely ascending surface. The pygidium is concealed by the elytra in our species, but is visible in some foreign genera, The eyes are large, and not concealed, even when the head is deflexed; they are closely approximate on the front, but widely distant beneath and finely granulated. The beak is long and slender, only slightly curved, and is received in a deep prosternal canal, which in some species does not extend upon the mesosternum, so that the end of the beak is free, as in *Conotrachelus*; even when, as in others, the mesosternum is excavated, the canal is open and not sharply limited behind. Legs slender, front coxæ elongated, and prolonged into a point on the inner side, claws simple, divergent.

Our species are of small size, and represent three genera:

Mesosternum declivous	....	2.
" excavated	....	PIAZURUS.
2. Ventral surface obliquely ascending	....	COPTURUS.
" " nearly horizontal	....	ACOPTUS.

PIAZURUS Sch.

I refer to this genus three small species which differ from *Copturus* not only by the excavated mesosternum, but by the thighs being armed beneath with a small but distinct tooth. The scales are smaller than in *Copturus*, and some of them are elongate. The elytra in well preserved specimens are marked with a sutural common white spot behind the middle, though in *P. subfasciatus* this spot is much less conspicuous.

Digitized by Google

Prothorax about as long as wide; elytral white spot conspicuous;
Elytra but little wider than prothorax..... **1. californicus.**
Elytra much wider than prothorax......... **2. oculatus.**
Prothorax conspicuously wider than long. Elytra much wider than prothorax.................... **3. subfasciatus.**

1. **P. californicus**, n. sp.

Elongate-oval, black, above irregularly clothed with narrow fulvous scales, mixed at the sides of the prothorax with white; scutellum black; elytra with a common sutural spot behind the middle, extending to the second stria, and a few scattered dots white. Beak rather stout, finely punctured, feebly carinate near the base; front very narrow; eyes bordered behind with pale scales. Prothorax not wider than long, gradually narrowed from base to tip, sides straight; disc coarsely densely punctured, distinctly carinate. Elytra very little wider than the prothorax, elongate, humeri oblique, striæ well impressed, interspaces flat, finely punctured. Beneath clothed with dirty gray scales; thighs distinctly toothed, hind pair with a black ring; tibiæ with a small terminal hook; ungues very small. Length 3 mm.; .12 inch.

Calaveras, California; Mr. Crotch. More elongate than the other two species, and resembling in form *Copturus operculatus*, though smaller.

2. **P. oculatus.** *Cryptorhynchus ocul.* Say, Journ. Ac. Nat. Sc. iii, 308; ed. lec. ii, 172; *Copturus nanus*‡ Dej. Cat.

Southern and Western States. The sutural white spot is small and extends only to the first stria. The upper surface is thinly clothed with fulvous hair-like scales, and only slightly mottled. The prothorax is nearly as long as wide, slightly rounded on the sides. The elytra are suddenly one-third wider than the prothorax and narrowed behind. Length 3 mm.; .12 inch.

3. **P. subfasciatus**, n. sp.

Rather stout in form, black, thinly and irregularly clothed with fine white hair-like scales, forming transverse bands on the elytra; the white spot is therefore not very conspicuous. Beak brown, outer half nearly smooth, base punctured and striate; antennæ testaceous, front very narrow. Prothorax about twice as wide as long, narrowed gradually from the base, sides feebly rounded behind, and very slightly sinuate near the tip; very coarsely and densely punctured, not carinate; the white scales are thinly placed, and form three broad vittæ. Elytra near the base about one-third wider than the prothorax, humeri more rounded and less prominent than in *P. oculatus*; narrowed behind, striæ wide, deep, punctured, interspaces narrow, with lines of white pubescence, so interrupted as to produce three transverse bands; one basal, surrounding a humeral dark spot, one behind the middle, and one near the tip; these bands are also connected along the suture, and at other places. Beneath thinly clothed with gray scales,

Digitized by Google

thighs acutely toothed, hind pair with an indistinct dark band. Length 1.7 mm.; .07 inch.

New York, one specimen; Mr. Guex. A peculiar species, somewhat suggestive of *Ceutorhynchus*. The elytral striæ are so wide and deep, that the pattern which is formed by white hairs on the interspaces seems to be made up of sets of very fine white lines.

COPTURUS Sch.

The species belonging to our fauna are small and elongate, with the elytra only a little wider than the prothorax. They differ from the typical species of tropical America by the femora being not armed with a tooth. We have seen already in many genera that this character is quite unimportant, and I consider it unworthy of even subgeneric distinction.

Our species may be thus tabulated:

	Second joint of funicle longer than third.........	**2.**
	" " not " "	**10.**
2.	Front moderately narrow........................	**3.**
	" very narrow, linear........................	**9.**
3.	Mottling of upper surface not very distinct.......	**4.**
	" " " very conspicuous.......	**5.**
4.	Larger, less densely clothed with scales..........	**1. operculatus.**
	Smaller, more " " " "	**2. nanulus.**
5.	Elytra with white markings.....................	**6.**
	" each with a large dark spot................	**7. binotatus.**
6.	Prothorax coarsely punctured....................	**7.**
	" finely punctured......................	**6. longulus.**
7.	Body more slender............................	**8.**
	Body rather stout; each elytron with a conical process at tip..................................	**3. mammillatus.**
8.	Prothorax less narrowed in front................	**4. adspersus.***
	" less elongate, more suddenly narrowed in front...........................	**5. quercus.**
9.	Elytra with fulvous scales and an oblique, dark, curved band................................	**8. lunatus.**
10.	Very small, elytra brown with white markings....	**9. minutus.**

1. **C. operculatus** Gyll., Sch. Curc. iv, 648; *Cryptorhynchus operc.* Say, Journ. Ac. Nat. Sc. Phila. iii, 308; ed. Lec. ii, 172.

Western and Southern States. The typical form is of larger size (4 mm.; .16 inch) than our other species, with the scales not very dense upon the elytra, so that the striæ are plainly seen; the spots of paler scales are few, and not conspicuous.

2. **C. nanulus**, n. sp.

This species agrees with the preceding in form, color and sculpture, but is very much smaller, the prothorax seems a little more elongate, and the

* I have some doubts as to the specific difference between *C. quercus* and *adspersus*, but for the present it seems more prudent to consider them as distinct.

Digitized by Google

sides are slightly rounded near the base; the scales of the elytra are comparatively larger and denser, and there is no distinct pattern of paler spots. Length 2.3 mm.; .09 inch.

Georgia, Illinois and Texas. The paler scales in well-preserved individuals are condensed so as to give the appearance of three vittæ on the prothorax, and to leave two faint dark clouds on each elytron, one about the middle, the other near the tip, separated by a sutural line and limited by pale bands.

3. **C. mammillatus**, n. sp.

As large as the largest specimens of *C. operculatus*, but distinctly broader; black, clothed with large oval scales of a light and dark brown color. Beak densely punctured, subcarinate; front half as wide as the beak. Prothorax not wider than long, sides feebly rounded, narrowed near the tip, and rather strongly constricted; coarsely and densely punctured, with a large subquadrate spot of white scales at the hind angles. Elytra slightly rounded on the sides, suddenly sinuate near the tip, and then broadly rounded; the tips are separately thickened and produced into a stout, conical, ascending process; the striæ are punctured as usual, and the interspaces feebly convex; the color is mottled, pale and dark brown and white. Beneath the metasternum and first and second ventral segments are covered with pale scales, the rest darker; second ventral with two tubercles near the posterior margin, about as distant from each other as from the side. Length 4.1 mm.; .16 inch.

Southern California; one specimen collected by Mr. Hardy, and kindly given me by Dr. David Sharp. The white spots of the elytra are as follows: a small dot at the base of the sixth interspace; a transverse spot on the second and third interspaces, one-fourth from the base; immediately behind this spot is a large, dark space; a smaller transverse spot behind the middle; a large lateral spot opposite the first ventral segment, and an adjoining small spot on the seventh interspace; the apical edge is also clothed with whitish scales.

4. **C. adspersus**, n. sp.

Elongate, black, beneath densely clothed with dirty white scales, above with ochreous scales, varied with dark brown and white spots. Head and front as in *C. operculatus;* antennæ pale testaceous, second joint of funicle longer than the third. Prothorax longer than wide, narrowed and feebly constricted near the tip; surface coarsely and densely punctured, scales large, rounded, concealing the punctures, the white spots are three at the base and three at the tip, indicating thus three, more or less interrupted white vittæ. Elytra with well marked punctured striæ, and flat interspaces; white marks conspicuous, indicating an annular basal mark, composed of small spots, then a long sutural line, and two oblique, interrupted bands behind the middle. Hind thighs with an indistinct band. Length 3.3 mm.; .13 inch.

Texas; four specimens. The scales are as large as in *C. operculatus.*

Digitized by Google

A specimen from Owen's Valley, California (Dr. Horn), is much less conspicuously colored.

5. **C. quercus** Gyll., Sch. Curc. iv, 650; *Zygops quercus* Say, Curc. 20; ed. Lec. i, 286.

Middle States; two specimens. The antennæ in this species are dark or piceous; the scales are smaller than in *C. operculatus*. The prothorax is less elongate, and is rather suddenly narrowed near the tip; it is coarsely punctured and marked with three white basal spots, the side ones being larger. The elytral pattern seems to be the same as in *C. adspersus*, but is partly abraded in my specimens, and it apparently differs from that species chiefly by the darker antennæ and less elongate prothorax.

6. **C. longulus,** n. sp.

Elongate, brown, beneath densely clothed with white scales, head and base of beak also densely clothed with white scales; front narrower than in *C. operculatus*; beak rather stout, black, nearly smooth; antennæ pale testaceous, second joint of funicle longer than third. Prothorax evidently longer than wide, scarcely narrowed in front, feebly constricted near the tip, rather finely granulato-punctate, with three small basal, and two discoidal spots of white scales. Elytra densely clothed with brown scales and a pattern of white markings, consisting of an irregular oblique band from the humerus to the middle, and a less oblique one behind the middle, united with the former at the suture; there are also scattered dots of white scales. Legs banded and speckled with brown. Length 2.3 mm., .09 inch.

California (Geysers), and Utah; Canada, Pettit. The scales of this are much smaller than in the preceding and following species.

7. **C. binotatus,** n. sp.

Black, densely clothed with dark gray scales, which are small on the prothorax, and large on the elytra, upon each of which is a very large subquadrate, blackish brown spot. Head and base of beak clothed with scales; beak and antennæ black; front narrower than in *C. operculatus*. Prothorax scarcely longer than wide, slightly narrowed in front, very feebly constricted near the tip, densely and deeply punctured, punctures concealed by small rounded gray scales. Elytra with deep punctured striæ and somewhat convex interspaces, densely covered with larger rounded gray scales; each with a large spot, covered with dark brown scales, occupying nearly the middle third of the surface, and extending from the first or second stria to the eighth. Length 2.5 mm.; .10 inch.

Pennsylvania and Texas; two specimens.

8. **C. lunatus,** n. sp.

Blackish brown, head and base of beak clothed with white, hair-like scales, beak more slender than usual, smooth, front very narrow, linear; antennæ nearly black, second joint of funicle longer than third. Prothorax longer than wide, slightly and gradually narrowed in front, sides scarcely rounded;

Digitized by Google

coarsely and densely punctured, clothed with large brown scales, and sprinkled with paler, with two large basal spots of dirty white. Elytra with deep punctured striæ, clothed with yellow and gray scales, with a curved band, extending from the humeri to behind the middle, then curving forwards and meeting the suture at the middle, thus forming on each an oblique lunule of dark brown. Beneath densely clothed with large, yellowish and grayish scales, legs slightly speckled with dark; thighs as in the other species, unarmed. Length 2.5 mm.; .10 inch.

California; one specimen, collected by W. H. Pease, probably at San Francisco.

9. **C. minutus.** *Eccoptus minutus* Lec., Ann. Lyc. Nat. New York, i. 171, pl. 11, fig. 8.

Easily known by the small size and different style of coloration, which is well represented in the figure given by my father, as above cited.

The beak, antennæ, legs and elytra are reddish brown, the latter with deep striæ, and lines of white narrow scales, forming a broad basal band, an oblique band behind the middle, and a narrow apical margin; the suture is also white, but interrupted about the middle. Beneath and legs rather thinly clothed with narrow white scales. The head and prothorax are darker than the elytra, the latter is deeply punctured, with a lateral vitta and a small ante-scutellar spot of white scales. The eyes are very large, the front extremely narrow. Length 2 mm.; .08 inch.

Southern States. Differs from all the preceding by the second joint of the funicle of the antennæ not longer then the third.

ACOPTUS n. g.

This genus differs from *Copturus* by the ventral surface being nearly horizontal, the segments much less unequal, and the sutures nearly straight, as in *Zygops*. It is essentially different from that genus by only the first joint of the funicle of the antennæ being elongated, and by the pygidium being covered by the elytra. The mesosternum is long, flat, and slightly declivous.

The second, third and fourth ventral segments are nearly equal, and the fifth is slightly longer, and broadly impressed in the specimen examined.

1. **A. suturalis**, n. sp.

Elongate, subcylindrical, black, sprinkled with small whitish scales, forming two very indefinite bands upon the elytra. Beak as long as the prothorax, cylindrical, curved, punctured, slightly carinate behind, without scales, except at the base; eyes very large, front extremely narrow, linear; head clothed with scales. Prothorax wider than long, slightly rounded on the sides, narrowed in front, where it is broadly constricted; densely punctured; dorsal line elevated, reaching neither base nor tip. Elytra a little wider than the prothorax, impressed near the base; striæ deep, interspaces flat, densely punctured; scales scattered, more condensed in two transverse bands, in front and behind the middle; scutellum and sutural line as far as

Digitized by Google

one-fourth the length, densely clothed with white scales; legs slender, sparsely clothed with scales; thighs feebly toothed, the hind pair more distinctly; antennæ black, rather stout, first joint only of funicle elongated. Length 3.8 mm.; .15 inch.

New York; several specimens in Mr. Ulke's collection, of which he has kindly given me one.

Tribe XVII. TACHYGONINI.

This tribe contains a few small species, which in form and characters are among the strangest insects of the family. The body is broadly ovate, rather depressed above, and ornamented with tufts of hair; the prothorax is comparatively small, much narrowed in front. The head is small, the eyes large, and the front very narrow, as in *Zygopini;* the beak is rather short and stout, as in certain *Ceutorhynchini*, and retracted upon the prosternum, but the antennæ are straight, inserted near the base of the beak, not geniculate, and the first joint (scape), is no longer than the second; this is followed by five short joints, gradually increasing in width; the club is elongate-oval, distinctly annulated. The front coxæ are sub-conical, prominent and widely separated, so as to leave a space in which the beak rests when retracted. The middle coxæ are about three times more separated than the front coxæ, and the mesosternum is very short, transverse, and perpendicular to the general surface of the metasternum, which is still wider. The side pieces of the mesosternum are large and distinct, those of the metasternum are narrow. The hind coxæ are oval, more widely separated than in any other tribe known to me, and near the side margin of the elytra. The first and second ventral segments are very large and connate; the third and fourth very short; the fifth is nearly as long as the second, rounded behind. The pygidium is exposed, and suddenly declivous at tip, presenting the appearance of an anal segment in both sexes. The front and middle legs are slender and moderate in length, the tibiæ armed with a terminal hook; the third joint of the tarsi is very widely dilated, the fourth joint as long as the first, with divaricate and appendiculate ungues. The hind legs are much longer and stouter, so as to clasp the leaves upon which the insect rests.

The geographical distribution is remarkable; a few species of *Tachygonus* in America; one species of *Dinorhopala* in Birmah. This fact, and the extraordinary characters above detailed, indicate the preservation of an ancient form, which, although having the affinities I have mentioned, is equally out of place in any position in a linear arrangement.

TACHYGONUS Sch.

The characters of this genus are sufficiently exposed in the description of the tribe. Our species are four, which may be thus distinguished:

A. Hind thighs armed with several long, acute spinules or teeth; hind tibiæ flattened and curved, feebly toothed on outer margin.

Digitized by Google

Pubescence gray-brown and black, tufted.......... **1. Lecontei.**

B. Hind thighs less strongly toothed, hind tibiæ slender.

Black, thinly pubescent with stiff, erect hair; a white sutural spot near the middle.............. **2. centralis.**

Pale brown, varied with dusky, elytra with four black spots, pubescent with erect hair, and with a central white sutural spot; hind legs dark....... **3. tardipes.**

Smaller, brown, varied with dusky; elytra with a more elongate white sutural spot; hind legs brown.. **4. fulvipes.**

1. **T. Lecontei** Gyll., Sch. Curc. i, 312; Sturm, Cat. 1843, 352; pl. 6, f. 1; Zimm., Germ. Zeitschr. ii, 455, (habits); *T. horridus* Chevr., Guer. Icon. Règne An. 155, pl. 38, f. 9.

Maryland, southward to Texas; found on the leaves of young oaks, on the under surface of which the insect sits, and falls to the ground when approached, as observed by Zimmermann. The hind legs, though long and powerful, are not saltatorial, as, indeed, is evident from their form and position; but being widely separated and capable of lateral extension, they give to the insect a grasping power which is very great in proportion to its small size. The curious movements in which, when about to alight it turns itself back downwards, and seizes the leaf with the elongated curved hind legs, are very well described by Zimmermann, in the passage above cited.

2. **T. centralis** Lec., Trans. Am. Ent. Soc. ii, 55.

Raton Mountain, Colorado, on *Rhus aromaticum*. The hind thighs are rather serrulate than toothed, the hind tibiæ are straight, not flattened. The color is uniform black, the elytral striæ are somewhat confused, and the white spot is very small.

3. **T. tardipes**, n. sp.

Pale brown, head, middle of prothorax, body beneath, hind legs in part, scutellum, and four large spots on the elytra, blackish. Body above thinly clothed with long, erect, gray hairs; prothorax not densely punctured, with a tuft of fine, soft, whitish hair at the basal angles. Elytra with rows of deep subquadrate punctures, interspaces narrow convex: with an angulated sutural spot in front of the middle, of soft, white hair, and a few scattered small tufts of the same; each elytron with a large, dusky spot on the humerus, and a smaller round one near the tip. Beneath strongly punctured, pubescent with erect hair, sides of trunk with a line of soft, whitish hair. Length 2.3 mm.; .09 inch.

Texas; one specimen given me by Mr. W. Jülich; one also in the collection of Dr. Horn. The hind thighs are blackish, finely subserrate beneath; the hind tibiæ are longer than the tarsi, pale towards the tip, not flattened, slightly curved, finely subserrate on the outer side; tarsi brown.

4. **T. fulvipes**, n. sp.

Brown, feet uniform reddish testaceous. Body above thinly clothed

Digitized by Google

with long, erect, gray hairs; prothorax sparsely and coarsely punctured, with a tuft of white hair at the basal angles. Elytra with regular striæ composed of large punctures; interspaces narrower than in *T. tardipes;* an elongate sutural spot of white hair in front of the middle. Hind thighs with about four small teeth on the under side; hind tibiæ comparatively shorter than in *T. tardipes*, not serrate on the outer edge. Length 1.8 mm.; .07 inch.

Illinois; Dr. Horn. Smaller than the smallest *T. centralis*, with the rows of elytral punctures more regular, and the white spot more elongated.

Tribe XVIII. CEUTORHYNCHINI.

This numerous tribe consists of small species of broad form, with the beak and pectoral groove varying according to genus. They are distinguished from all the preceding tribes with distant front coxæ, by the pygidium being perpendicularly deflexed, and marked with a deep excavation (*Mononychus*), or with a continuation of the acute lateral margin of the ventral segments, against which the apical margin of the elytra rests. In the latter case, the upper part of the dorsal segment is finely carinate; in both cases, the anal segment of the ♂ extends in front of the excavation or transverse line. In all the genera the coriaceous sutural margin of the left elytron is much wider than in any genera of the Cryptorhynchoid series, including *Zygopini*.

The antennæ are geniculate as usual, inserted ahout the middle of the beak; the funicle is 6–7-jointed, and the club oval-pointed, pubescent and annulated. The side pieces of the mesosternum are usually visible from above.

They may be divided into four groups, the first of which indicates more properly a sub-tribe.

A. Pygidium without transverse line for reception of tip of elytra; pectoral groove extending upon the metasternum.................................... **Mononychi.**
B. Pygidium with line for reception of tip of elytra, and carinate in front of the line:
  Pectoral groove, extending behind the prosternum.. **Cœliodes.**
  Pectoral groove anterior, sometimes effaced.
    Beak long and slender.......................... **Ceutorhynchi.**
    Beak stout, usually short....................... **Phytobii.**

Group I. Mononychi.

A single genus constitutes this tribe. The species are of broad form, and larger than any others in the tribe, and are easily distinguished by the pygidium not being carinate in front, and with no transverse line for the reception of the tip of the elytra; the declivous exposed portion is, however, gibbous at the upper part, surrounded with an impression, distinctly margined in the male; in the female there is a small, very deep excavation, surrounded

Digitized by Google

by a thickened margin. The eyes are partially covered when the head is deflexed, and the beak, which is long and cylindrical, rests in a deep groove extending through the pro- and mesosternum, into the metasternum, where it is sharply limited. The side pieces of the meso- and metasternum are very large. The ventral sutures are curved at the sides; the first segment is as long as the metasternum, the second is shorter, third and fourth together equal to the second; fifth nearly as long as the first, truncate and impressed in the male. Legs slender, thighs slightly clubbed, tibiæ obliquely fringed at the tip, terminal hook very small at the inner angle. Tarsi with the third joint very broad, bilobed; fourth joint small, with a single claw.

MONONYCHUS Germ.

The genus is sufficiently defined by the characters of the group. One species occurs in our fauna; otherwise it is represented by six species in Europe, Northern Asia, and one in the Canary Islands.

1. **M. vulpeculus** Boh., Sch. Curc. iv, 309; *Rhynchænus vulp.* Fabr., Syst. El. ii, 450; Oliv., Ent. v, No. 83, 129, pl. 29, f. 437; Say, Curc. 20; ed. Lec. i, 286 (habits).

Canada to Georgia, on Iris. Say states that it also occurs on the flowers of *Ceanothus americanus*, and *Verbascum thapsus* in July.

Group II. Cœliodes.

In the species of this group the eyes are partially covered by postocular lobes, when the head is deflexed, and the pectoral groove extends into or beyond the mesosternum, the beak is long and cylindrical. The side pieces of the meso- and metasternum are large and wide. The ventral sutures are curved, and the first is as deeply impressed as the others; the second segment is shorter than the first; third and fourth still shorter, fifth nearly as long as the first. The pygidium is perpendicularly deflexed, marked with an elevated angulated line for the reception of the tips of the elytra, in front of which it is carinated. The third joint of the tarsi is very broad and bilobed, the fourth is as long as the first, with two claws, which are cleft, or toothed.

The following genera are represented in our fauna:

Tibiæ flattened, toothed on the outer side.........	2.
" slender, not dilated nor grooved............	3.
2. Pectoral groove extending to the metasternum....	CRAPONIUS.
" " not extending to the metasternum	CNEMOGONUS.
3. Body broadly ovate, elytra suddenly wider.......	CŒLIODES.
" pyriform, elytra gradually wider...........	ACALLODES.

CRAPONIUS n. g.

A single species which differs remarkably from *Cœliodes* by the tibiæ being flattened, dilated, angulated on the outer margin near the base, and broadly grooved externally for the partial reception of the tarsi. It has. in

Digitized by Google

addition, the pectoral groove prolonged to the posterior margin of the metasternum. The funicle of the antennæ is slender, and consists of seven joints, of which the second is as long as the three following. The claws are armed with an acute tooth, half as long as the claw.

1. **C. inæqualis.** *Ceutorhynchus inæq.* Say, Curc. 20; ed. Lec. i, 286.
Middle, Southern and Western States. Easily known by the broad form and dark color; the prothorax has four large tubercles, of which the outer ones are acute; the dorsal canal is prolonged to the apical margin, which is slightly emarginated thereby. The alternate interspaces of the elytra are more elevated and somewhat uneven, as in certain *Conotracheli*. Length 2.7 mm.; .11 inch.

CNEMOGONUS n. g.

The tibiæ of one species are so different from those of the other *Cœliodes*, that I am obliged to regard it as a separate genus. They are, namely, much flattened and dilated externally, so as to form a large angle near the knee. The outer apical angle of the front tibiæ is prolonged in a toothed process, as in *Cœliodes*, and the other tibiæ are obliquely truncate and fringed externally. In other respects this genus agrees with *Cœliodes;* the pectoral groove is not prolonged into the metasternum, as in *Craponius*, nor are the tibiæ grooved externally for the reception of the tarsi. The thighs are not toothed, and the claws are armed with a short tooth, not cleft, as in *Cœliodes*.

C. epilobii. *Curc. epilobii* Payk., Faun. Suec. iii, 259; *Rhynchænus ep.* Gyll., &c.; *Cœliodes ep.* Gyll., Sch. Curc. iv, 288, &c.
Widely diffused in Europe, from Scandinavia to Austria. I have a specimen from Great Slave Lake, and one from British Columbia, which seem to be the same. Apart from the generic characters above given, this species is easily known by the interspaces of the elytra, rough with small acute tubercles; near the base there is a small cruciform white spot, formed by the junction of a short sutural line with a transverse one, which extends to the third stria. Length 3.2 mm.; .125 inch.

CŒLIODES Sch.

In this genus the tibiæ are slender, not flattened nor toothed on the outer margin, but the front pair, in some species, are prolonged at the outer apical angle into a short process, which is toothed on the lower edge. The pectoral groove extends as far as, but not upon, the metasternum. The claws are nearly cleft, the inner parts being almost contiguous, as in most species of *Anthonomus*.

A. Front tibiæ prolonged outwards at tip: thighs unarmed.	
Interspaces of elytra convex......................	1. **curtus.**
Interspaces of elytra flat........................	2. **acephalus.**
B. Front tibiæ not prolonged at tip: thighs unarmed.	
Elytra with rows of acute tubercles................	2.

Digitized by Google

	Elytra not tuberculate; or only feebly muricate towards the tip..................................	**3.**
2.	Black, thinly pubescent; elytra with a white basal spot..	**3. tenuipes.**
	Brown, mottled with white hair..................	**4. asper.**
3.	Tibiæ slender, not angulated.....................	**4.**
	" with parallel sides, subangulated near the base	**5. cruralis.**
4.	Apical teeth of prothorax distinct..................	**6. nebulosus.**
	" " " wanting..........	**7. nasalis.**
C.	Thighs armed with a tooth.......	**8. flavicaudis.**

1. **C. curtus** Gyll., Sch. Curc. iv, 287; *Ceutorhynchus curt.* Say, Curc. 29. ed. Lec. i, 298.

Southern States; two specimens.

2. **C. acephalus** Germ., Sch. Curc. iv, 289; *Falciger aceph.* Say, Journ. Ac. Nat. Sc. Phila. iii, 309; ed. Lec. i, 173; *C. subulirostris* Gyll., Sch. Curc. iv, 288; *C. leprosus* Boheman, Sch. Curc. viii, 1, 394.

Middle and Western States. The scales are sometimes mottled, sometimes nearly uniform in color. The beak is cylindrical in ♂, narrowed towards the tip in ♀.

3. **C. tenuipes,** n. sp.

Black, thinly clothed with fine depressed hair-like scales. Beak punctured, carinate. Prothorax very coarsely punctured, dorsal channel deep towards the base, lateral tubercle small but acute. Elytra with the striæ wide, deep and punctured; interspaces hardly wider than the striæ, rough with small acute tubercles; base with a common whitish spot at the scutellar region. Legs slender, thighs unarmed, tibiæ slightly curved; front pair without apical process. Claws cleft as usual. Length 2.5 mm.; .10 inch.

Texas, Belfrage; one ♂. Greatly resembles in appearance a *Ceutorhynchus*, but the beak is less slender, and the mesosternum is deeply concave

4. **C. asper,** n. sp.

Brown, mottled with coarse white scale-like hairs. Beak rather stout, coarsely punctured, flattened above, feebly carinate. Prothorax coarsely punctured, dorsal channel obsolete, lateral tubercles small, acute. Elytra deeply striate, interspaces wider than the striæ, convex, each with a row of large, distant, acute tubercles; tibiæ slender, slightly curved, front pair with a very small spine directed outwards, at the external apical angle. Length 2.2 mm,; .085 inch.

Texas, Belfrage. The white mottlings of the elytra do not form a distinct pattern, there is, however, a tendency to transverse bands, and a cruciform spot near the base.

5. **C. cruralis,** n. sp.

Black, thinly and irregularly mottled with white, scale-like hairs. Beak

Digitized by Google

slender, punctured, substriate near the base, finely carinate. Prothorax very coarsely punctured, dorsal channel broad, not deep, lateral tubercles acute. Elytra deeply striate, interspaces convex, wider than the striæ, not tuberculate; there is a distinct cruciform white spot near the base. Tibiæ slender, straight, with parallel sides from near the knee to the tip; front pair without spine at the outer apical angle. Length 2.2 mm.; .085 inch.

Anticosti, Mr. W. Couper, abundant; Lake Superior, Pennsylvania and Texas. Easily known by the peculiar form of the tibiæ, the external margin of which is obtusely angulated near the knee, but not at all dilated, nor grooved.

6. **C. nebulosus**, n. sp.

Broadly ovate, very dark brown. Beak stout and long, punctured, not carinate, scarcely striate towards the base. Prothorax coarsely punctured, broader than long, strongly narrowed in front; dorsal channel not deep, apical tubercles acute, not very distant, lateral tubercles acute, prominent. Elytra indistinctly mottled with very fine brown pubescence, and very small, white scales, not forming a definite pattern; striæ deep, punctured, interspaces rugose, very finely muricate towards the tip. Thighs not toothed, tibiæ slender, nearly straight. Length 2 mm.; .08 inch.

Detroit, Michigan; Messrs. Hubbard and Schwarz. I have three larger specimens, from Georgia and Pennsylvania, which I refer to this species, though they are of a darker color, and the white spots of the elytra are more distinct.

7. **C. nasalis**, n. sp.

Black, pruinose with a thin clothing of very fine white hair. Beak rather stout, coarsely punctured, flattened above, with three distinct carinæ. Prothorax coarsely punctured, dorsal channel deep behind, obsolete in front, lateral tubercles small, acute. Elytra with broad deep striæ, interspaces hardly wider than the striæ, flat; suture with a short line of white scales extending from the base for one-fourth the length. Tibiæ slender, slightly curved, front pair without spine at outer apical angle. Length 3.5 mm.; .14 inch.

Texas, Belfrage, one ♂. In this, as in *C. tenuipes*, *asper* and *cruralis* the postocular lobes of the prothorax are indistinct, and the front margin is nearly straight as far as the prosternum, which in the other species is deeply emarginate in front.

8. **C. flavicaudis** Boh., Sch. Curc. viii, 1, 397.

Unknown to me. The thighs are described as having a short, obtuse tooth beneath. This character will distinguish it from those above mentioned.

ACALLODES n. g.

This new genus is established upon an insect which has the same pyriform body as the European *Scleropterus*, but differs from that genus by the funicle having seven distinct joints, of which the first is longer and

Digitized by Google

thicker, and the second somewhat elongate; the others differ but little in length. The antecoxal ridges of the prosternum are very well developed, and the front coxæ are very prominent and not widely separated. The mesosternum is not properly sulcate, but the middle coxæ are large and very prominent, not widely separated, so that there is a narrow deep space between them. The metasternum is very short, and the hind coxæ widely separated. The thighs are slightly clavate, not toothed, the tibiæ are slender, the tarsi dilated, and the claws cleft. Scutellum not visible; pygidium exposed.

1. **A. ventricosus**, n. sp.

Ovate, very convex, dark brown, very finely pubescent; pubescence forming three vittæ on the prothorax and two bands on the elytra. Head strongly punctured, eyes distant, not convex, beak stout, curved, as long as the prothorax, strongly punctured, striate towards the base. Prothorax wider than long, gradually but strongly narrowed in front, rounded on the sides behind, constricted near the tip, apical margin not elevated, postocular lobes obsolete; disc very coarsely punctured, dorsal channel distinct, lateral tubercles obsolete. Elytra ventricose, gradually wider than the prothorax, obliquely narrowed behind the middle and strongly declivous, striæ very deep, punctured, interspaces not wider, convex; an elongate basal spot on the suture of white scales; space between the two bands of fine gray pubescence, darker. Beneath coarsely punctured, finely and sparsely pubescent. Legs and antennæ lighter brown. Length 2.5 mm.; .10 inch.

Middle and Western States, two specimens.

Group III. **Ceutorhynchi.**

The species of this group are small, and of the broad ovate form usual in the tribe. They differ from the preceding group by the pectoral groove not extending behind the front coxæ, and from the next group by the beak being long, slender, and curved; usually about half the length of the body. The eyes are small, not prominent, and are partially concealed in repose by broad prothoracic lobes. The prosternum is suddenly and very deeply emarginate in front, and the antecoxal ridges defining the pectoral groove are acute and elevated in all our species.

The beak is stouter and more coarsely sculptured in ♂, and the last ventral segment is impressed.* The species in our fauna are not very numerous, and all belong to *Ceutorhynchus*; some European species with 6-jointed funicle have been separated under the name *Ceutorhynchidius*, but I see nothing in our species sufficient to warrant the adoption of such a division.

* By an unfortunate error, Suffrian (Ent. Zeitung, 1845, 102) has stated that the females have the ventral impression. Thompson, however, (Skand. Col. vii, passim), reports the sexual difference correctly.

Digitized by Google

According to the form of the claws and the number of joints of the funicle the species fall into natural groups, as follows:

A. Claws cleft.
  a. Funicle 7-jointed.......................... Sp. 1-3.
  b. Funicle 6-jointed.......................... Sp. 4.
B. Claws toothed near the base; funicle 7-jointed.. Sp. 5-8.
C. Claws simple.
  a. Funicle 7-jointed.......................... Sp. 9-10.
  b. Funicle 6-jointed.......................... Sp. 11-18.

A-a. Claws cleft; funicle 7-jointed; thighs toothed.
  More finely sculptured; elytra without basal spot;
    Pubescence very fine, brown................. 1. **subpubescens.**
    " coarser, gray..................... 2. **rapæ.**
  Coarsely sculptured, elytra with white basal spot 3. **sulcipennis.**
A-b. Claws cleft, funiculus 6-jointed; thighs toothed.
  Coarsely sculptured, elytra with a white basal spot 4. **decipiens.**
B. Claws toothed at the base; funicle 7-jointed.
  Prothorax more finely punctured............... 2.
  " very coarsely punctured, deeply sulcate 5. **rudis.**
2. Elytra without conspicuous basal spot, thighs not toothed.............................. 3.
  Elytra with conspicuous basal spot, thighs toothed 6. **sericans.**
3. Prothorax with sides much rounded............ 7. **convexicollis.**
  " " " more oblique............. 8. **pusillus.**
C-a. Claws simple; funicle 7-jointed.
  Brown, mottled above with fine pubescence...... 9. **pusio.**
  " spotted with large white scales.......... 10. **squamatus.**
C-b. Claws simple; funicle 6-jointed.
  Elytra with spots of white scales............... 2.
  " " an indistinct basal spot............ 3.
2. Elytra with a narrow angulated band.......... 11. **angulatus.**
  " " an oblique lateral spot............. 12. **obliquus.**
  " " basal spot and larger lateral one.... 13. **tau.**
  " with suture and lateral spot white; red behind the middle....................... 14. **semirufus.**
  Elytra with broad pale sutural vitta........... 15. **medialis.**
3. Densely clothed with small appressed hair-like scales.................................. 16. **septentrionalis.**
  Brown, coarsely squamose.................... 17. **Zimmermanni.**
  Blackish, clothed with scale-like pubescence not appressed............................ 18. **puberulus.**

A—a.

1. **C. subpubescens**, n. sp.

Oblong, narrowed in front, brownish-black, above thinly clothed with very fine brown pubescence; beneath with small grayish scales. Head

Digitized by Google

densely punctured, occiput finely carinate. Beak half as long as the body, slender, cylindrical, shining and sparsely punctured towards the tip, striate and punctured, and carinate towards the base; eyes distant, front slightly concave. Prothorax a little wider than long, gradually but strongly narrowed in front, constricted near the tip, apical margin elevated, post-ocular lobes large and broad; disc densely punctured, dorsal channel deep, lateral tubercles small. Elytra oblong, wider than the prothorax, striæ rather fine, interspaces broad, flat, densely and strongly rugose and granulate. Funicle of antennæ rather long, first and second joint elongated, the first stouter; joints 3–7 gradually a little broader, club moderate, oval, pointed. Thighs acutely toothed, claws cleft. Length 3.2 mm.; .125 inch.

♂. Last ventral segment with two widely separated elevations.

Los Angeles and Tejon, California; Mr. Crotch. Very similar to the next, but the pubescence of the upper surface is much finer, and not gray, but brown, and the interspaces of the elytra are much more rough.

2. C. rapæ Gyll., Sch. Curc. iv, 547; Redt., Fauna Austr. 805; Thoms., Skand. Col. vii, 271.

Canada, Middle and Western States; also in northern and middle Europe. The interspaces of the elytra are finely rugose, and towards the tip are sparsely muricate with elevated acute granules. The last ventral segment as in the preceding species has two distant tubercles in the male.

3. **C. sulcipennis**, n. sp.

Rather broader ovate, black, clothed beneath with small whitish scales, above very slightly pubescent. Head and beak punctured, the latter curved, not distinctly striate at the base; occiput finely carinate. Prothorax wider than long, narrowed in front, somewhat rounded on the sides, slightly constricted near the tip; apical margin slightly elevated, postocular lobes entirely wanting; disc coarsely confluently punctured, channeled, lateral tubercles distinct, acute. Elytra deeply sulcate; interspaces not wider than the striæ, rough and muricate; an elongate basal spot on the suture, composed of small white scales, sometimes removed by abrasion. Funicle slender, first joint nearly as long as the second, and stouter; third nearly as long as the second; 4–7 gradually shorter, but scarcely thicker; club moderate, oval pointed. Thighs acutely toothed, claws cleft. Length 2.5 mm.; .10 inch.

♂. Last ventral segment with a shallow circular impression. Beak stouter, densely punctured.

♀. Last ventral segment not impressed; beak longer, more slender, less densely punctured.

Southern and Western States. The mesosternum is slightly concave; indicating a pectoral groove, though without ridges. In this character, as well as by the stouter and more densely punctured beak of the ♂, it shows a tendency towards *Cœliodes*.

Digitized by Google

A—b.

4. **C. decipiens**, n. sp.

Rather elongate, black, beneath clothed with gray scales, above with a few scattered white hairs, and an elongate white sutural spot at the base of the elytra. Head densely punctured; beak (♂) half as long as the body, cylindrical, curved, strongly punctured, striate and carinate towards the base. Prothorax as long as wide, narrowed in front, sides slightly rounded behind, sinuate in front, broadly constricted near the tip, apical margin not elevated, postocular lobes very feeble, disc very coarsely punctured, channeled behind, tubercles wanting. Elytra elongate-oval, wider than the prothorax, convex, very deeply striate, interspaces not wider than the striæ, convex, rough with acute granules. Antennæ with 6-jointed funicle; first and second joint longer, the first stouter, club moderate, oval-pointed. Thighs armed with a small but acute tooth; tibiæ rather less slender than usual, claws cleft. Length 2.4 mm.; .09 inch.

♂. Last ventral segment with a transverse apical impression.

Kansas and Michigan; two ♂. This species has a singular resemblance in form and color to *Rhinoncus longulus*, but the beak and sculpture of the elytra are quite different. The generic characters seem to be very nearly those of *Rhytidisomus*, but the elytra, though rounded in form are more elongate. I infer therefore that that genus, founded upon a single European species should be suppressed.

B.

5. **C. rudis**, n. sp.

Dark brown, beneath densely clothed with rather large dirt-colored scales, above thinly pubescent with brown hair. Head densely punctured, finely carinate; beak (♀) half as long as the body, shining and sparsely punctured towards the tip, striate and punctured towards the base. Prothorax wider than long, strongly rounded on the sides, much narrowed and constricted near the tip; apical margin elevated, postocular lobes broad and feeble; disc convex very coarsely punctured, very deeply channeled, with pale scales in the channel and at the middle of the apex; tubercles wanting. Elytra deeply striate, interspaces wider, somewhat convex, rough. Funicle rather long, 7-jointed, first and second joints longer, the first stouter; club moderate, oval pointed. Legs reddish testaceous, thighs strongly toothed, claws armed with a short, acute basal tooth. Length 2.8 mm.; .11 inch.

One badly preserved specimen; Kansas.

6. **C. sericans**, n. sp.

Oblong, depressed, dark brown, beneath densely clothed with small, gray scales, above with fine, scale-like brown hairs, with a silky lustre. Head densely punctured, feebly channeled, beak punctured and striate towards the base. Prothorax wider than long, sides nearly parallel behind, then strongly narrowed and constricted near the tip; apical margin elevated, postocular lobes large and broad; disc densely, not coarsely punctured,

Digitized by Google

channeled, lateral tubercles large, obtuse. Elytra striate, interspaces flat, wide, granulate, slightly mottled with white hairs; an elongate, snow-white sutural spot extends from the base for one-third the length. Thighs toothed, claws armed with a small basal tooth. Length 2 mm.; .08 inch.

One ♂, Calaveras, California; Mr. Crotch. The last ventral segment is deeply aud widely impressed. A very beautiful and easily recognized species.

7. **C. convexicollis**, n. sp.

Oblong, black, beneath clothed with gray scales, above uniformly densely covered with coarse dirt-colored pubescence. Head densely punctured, beak (♀) long, slender, slightly curved, shining; punctured towards the base. Prothorax wider than long, narrowed in front, strongly rounded on the sides, constricted near the tip, apical margin elevated, postocular lobes very feeble; disc coarsely punctured, deeply channeled. Elytra with deep punctured striæ, interspaces wide, flat, finely alutaceous. Antennæ testaceous, funicle slender, second joint longer and more slender than the first. Legs brown, thighs not toothed, claws with a long acute tooth. Length 2 mm.; .08 inch.

Texas, Belfrage, two ♀. Of the same general form as *C. rapæ*, but much smaller, and with a quite different prothorax.

9. **C. pusillus**, n. sp.

Oblong, depressed, dark brown, or ferruginous, clothed beneath with rather small gray scales, above with short rigid pubescence, mixed with similar scales. Head densely punctured, occiput finely carinate; beak slender, punctured, striate at the base. Prothorax wider than long, sides more obliquely rounded behind, suddenly narrowed and constricted in front, apical margin elevated; disc densely punctured, less deeply channeled, with a dorsal line of pale scales; posterior tubercles large, rather acute. Elytra with deep striæ, interspaces somewhat wider, slightly convex, sparsely rugose; a basal whitish spot, occupying the space from the suture to second stria. Funicle slender, 7-jointed; first and second joints longer, the first stouter; club moderate, oval pointed. Legs ferruginous, thighs not toothed, claws with an acute basal tooth. Length 2 mm.; .08 inch.

♂. Last ventral segment with a deep, round impression.

California and Oregon; not rare. Allied to *C. convexicollis;* differs chiefly by the sides of the prothorax less rounded, the dorsal channel less deep, and the lateral tubercles more acute. The whitish basal spot of the elytra is frequently indistinct; and I have indeed some specimens which have lost the scales of the upper surface, while retaining the pubescence. These present a very deceptive appearance, and look almost as if they belonged to a different species.

C—a.

9. **C. pusio Mann.**, Bull. Mosc., 1852, ii, 355.

Oblong, depressed, dark brown, beneath densely clothed with small,

Digitized by Google

pale scales; above mottled with fine, short, brown pubescence. Head densely punctulate, front broadly concave; beak not half as long as the body, slender, curved, nearly smooth and shining externally, punctulate and finely carinate towards the base. Prothorax wider than long, sides rounded behind, strongly narrowed and constricted near the tip; apical margin elevated, postocular lobes wanting; disc coarsely punctured, dorsal channel broad, subinterrupted, lateral tubercles large, acute. Elytra deeply striate, interspaces wider, slightly convex, sparsely and deeply rugose; scutellar region clothed with pale scales. Funicle with first and second joints elongated, first stouter; 3–7 gradually a little wider, club rather large, oval-pointed. Thighs not toothed, claws slender, not toothed. Length 2 mm.; .08 inch.

♂. Last ventral segment with a deep, round excavation.

Alaska. I owe two typical specimens to the kindness of Prof. Mæklin; it was also found by Mr. Crotch, at Clear Lake, California. In well preserved specimens, the sides of the prothorax and the dorsal channel are clothed with pale scales.

10. **C. squamatus**, n. sp.

Ovate, broad, dark piceous, depressed, beneath clothed with whitish scales, above thinly pubescent, with spots of large rounded, white scales. Head finely punctured; beak long, slender, much curved, nearly smooth towards the tip, finely striate towards the base. Prothorax wider than long, strongly narrowed in front, and constricted near the tip, apical margin elevated, ferruginous, postocular lobes wanting; disc densely punctured, dorsal channel feeble, lateral tubercles small, acute; sides and basal spot covered with white scales. Elytra with deep punctured striæ, interspaces wider, slightly convex, rugose, marked with scattered white scales; there is a large scutellar spot, and a transverse band behind the middle, densely clothed with white scales. Funicle slender; first and second joints longer, the first a little stouter, club elongate-oval, pointed. Thighs not toothed, claws slender, not toothed. Length 2 mm.; .08 inch.

♂. Last ventral segment with a deep transverse excavation.

Illinois; three specimens.

C—b.

11. **C. angulatus**, n. sp.

Oblong, depressed, brown or blackish brown, densely clothed above and beneath with small pale scales; a white, narrow, angulated band on each elytron, running from the side about one-third from the base obliquely backwards a short distance, then obliquely forwards to the scutellum. Head densely punctured, beak according to sex; front slightly concave. Prothorax wider than long, rounded on the sides, strongly narrowed and constricted in front, apical margin elevated, postocular lobes broad and distinct; disc covered with white scales at the sides, very densely punctured, dorsal channel deep, lateral tubercles acute, large. Elytra with rather shallow punctured striæ, interspaces wide, flat,

Digitized by Google

densely rugose. Funicle 6-jointed, first to third joints elongate, the first stouter; club oval-pointed. Thighs with a very small obtuse tooth, claws slender, simple. Length 3 mm.; .12 inch.

♂. Last ventral segment with a deep transverse excavation; beak less than half the length of the body, stouter, densely punctured.

♀. Last ventral segment not impressed; beak half the length of the body, more slender and more curved, nearly smooth towards the tip, strongly punctured and striate towards the base.

Vancouver Island and California. Among many specimens before me, there are only a few in which the markings are perfectly preserved; in these, besides the angulated narrow band above described, the apical part of the elytra is also clothed with white scales, especially towards the suture; but these scales are less densely placed than those in the band; there is also a spot at the middle of the base of the prothorax.

12. **C. obliquus**, n. sp.

Oblong, depressed, brown, densely clothed above and beneath with pale brown scales, which are smaller above. Head and beak like the preceding. Prothorax wider than long, rounded on the sides, strongly narrowed and constricted near the tip; apical margin elevated, postocular lobes broad, distinct; disc densely and more coarsely punctured than in *C. angulatus*, deeply channeled, lateral tubercles large, acute. Elytra less broad at base, striæ rather shallow, punctured, interspaces wide, flat, strongly rugose: a lateral oblique spot of dense whitish scales extends from the ninth to the fifth stria. Other characters and sexual differences as in *C. angulatus*. Length 2.4 mm.; .09 inch.

California at San Mateo; three specimens, Mr. Crotch. Closely related to the preceding, but more elongate, and with the scales uniform in color, except the white oblique spot towards the sides of the elytra.

13. **C. tau**, n. sp.

Ovate, narrowed in front, and less so behind, depressed, blackish, densely clothed with dark gray scales, which are smaller and more fuscous above. Beak curved, slender, sparsely punctured, striate towards the base. Head densely punctured. Prothorax as in *C. angulatus*, but more obliquely rounded on the sides. Elytra less oblong, more distinctly narrowed behind, similarly striate and rugose, with a large scutellar spot like an inverted **T**, and an oblique lateral spot densely clothed with gray scales. Antennæ and legs brown, similar to those of *C. angulatus*. Length 3 mm.; .12 inch.

One specimen, Texas; Belfrage. Also closely allied to the two preceding, and differing only by form and elytral spots.

14. **C. semirufus**, n. sp.

Ovate narrowed in front, and less so behind, brown; elytra behind the middle, antennæ and legs ferruginous; beneath densely clothed with white scales; above thinly and finely pubescent, with the suture and quadrate lateral spot of elytra clothed with white scales. Head densely punctured,

Digitized by Google

beak curved, punctured towards the tip, striate towards the base. Prothorax wider than long, rounded on the sides, narrowed and constricted in front, apical margin elevated; postocular lobes broad, distinct; disc strongly less densely punctured, deeply channeled, lateral tubercles acute, sides and dorsal line clothed with white scales. Elytra with punctured striæ, interspaces flat, shining, slightly punctulate. Thighs not toothed, claws slender, simple. Length 1.3 mm.; .05 inch.

Detroit, Messrs. Hubbard and Schwarz. A small species remarkable for the less pubescent upper surface, and peculiar coloration; seems related to the European *C. querceti*, but differs by the quadrate lateral white spot of the elytra.

15. **C. medialis**, n. sp.

Oblong, depressed, brown, beneath densely clothed with pale scales, above with fine brown hair-like scales. Head punctured, beak long, slender, curved, shining and nearly smooth towards the tip, punctured and substriate near the base. Prothorax wider than long, obliquely rounded on the sides, strongly narrowed and constricted near the tip, apical margin elevated, postocular lobes broad, indistinct; disc strongly punctured, dorsal channel not deep, lateral tubercles small but acute; sides and dorsal line clothed with pale scales. Elytra with punctured striæ, interspaces wider, flat, strongly rugose; sutural interspace and base of second densely clothed with pale scales; sides of elytra, especially behind the middle, less densely clothed with similar scales. Funicle 6-jointed. Thighs not toothed, claws slender, not toothed. Length 2 mm.; .08 inch.

Two specimens, Lake Superior. The beak is similar in the two specimens, but one of them, which I infer to be the ♂, has the last ventral segment very feebly impressed.

16. **C. septentrionalis** Gyll., Sch. Curc. iv, 492.

Lake Superior, Canada, and Pennsylvania; not rare. A small species, densely clothed above with depressed, scale-like pubescence, which has a feeble metallic lustre; in many specimens there is a faintly marked paler scutellar spot. The lateral tubercles of the prothorax are very small; the funicle 6-jointed; the thighs not toothed; the claws slender, not toothed. Length 2 mm.; .08 inch.

17. **C. Zimmermani** Gyll., Sch. Curc. iv, 492.

Canada to Texas. Still smaller, brown, clothed with small, pale scales above; lateral tubercles of prothorax very small; antennæ, thighs and claws, as in the preceding. The elytra and legs usually of a paler brown. Length 1.5 mm.; .06 inch.

18. **C. puberulus**, n. sp.

Oblong, depressed, blackish with a feeble metallic glimmer, beneath clothed with pale scales, above with short, coarse pubescence. Prothorax wider than long, much narrowed and constricted in front, apical margin elevated, postocular lobes broad, not distinct; densely punctured, dorsal channel distinct, not very deep, lateral tubercles small, acute. Elytra

Digitized by Google

deeply striate, interspaces flat, rugose. Funicle 6-jointed: thighs and claws not toothed. Length 1.7 mm.; .07 inch.

Canada and Michigan. A little larger and darker colored than *C. Zimmermanni*, from which it differs chiefly by the upper surface being covered with scale-like hairs, or small, elongate, hair-like scales; while in the preceding most of the scales are oval.

Group IV. **Phytobii.**

The species of this group differ from the *Ceutorhynchi* only by the beak being stout, and usually short, in one instance scarcely as long as the prothorax. The prothoracic lobes are feeble or wanting, the eyes are sometimes partially covered in repose, sometimes entirely free. The pectoral groove is sometimes well defined by antecoxal ridges on the prosternum, but occasionally these are absent. The first genus exhibits a very singular reversion towards the *Bagous* group, with which it might indeed be placed, were it not that the pygidium is exposed, and similar in sculpture to that of the other members of the present tribe, and, also, that other characters correspond with the position here assigned to it.

The genera are somewhat difficult to define, in consequence of the important structural characters by which the species are distinguished. It is probable that they will be increased in future, by those whose views tend to the multiplication of genera, but for the present, I think that the divisions here adopted express both conveniently and naturally the affinities of the species known to me.

Tarsi with the third joint dilated, bilobed........	2.
" slender, long, not dilated..................	PHYTOBIUS.
2. Prosternum with acute antecoxal ridges..........	3.
" without " "	PELENOMUS.
3. Eyes with acutely elevated orbits................	CŒLOGASTER.
" without " "	RHINONCUS.

PHYTOBIUS Sch.

Eubrychius Thomson.

In this genus the beak is stout, cylindrical, nearly as long as the prothorax; the eyes are small, rounded, convex and fully exposed. Prothorax not much wider than the head, wider than long, slightly narrower at the tip, truncate before and behind, with a small angle at the scutellum; the disc is feebly longitudinally impressed behind the middle, and the lateral tubercles are small and indistinct. Elytra deeply striate, nearly twice as wide as the prothorax, and about three times as long, voluminous, broad at the base, gradually narrowed behind. Pygidium triangular, exposed. Legs long, slender, tibiæ nearly straight, not mucronate; tarsi not dilated, last joint as long as the others united, with rather large simple claws.

A remarkable and easily recognized genus, of which but one species is known. Schönherr divided *Phytobius* into two groups of which the first (*genuini*), was characterized by long slender tarsi. There is, therefore, no excuse for retaining the name for the second group, (*spurii*) and it must be restored to this genus afterwards named *Eubrychius* by Thomson.

Digitized by Google

1. **P. velatus** Gyll., Sch. Curc. iii, 459; *Rhynchænus vel.* Beck, Beitr. Bayersch. Ins. Fauna, 20; *Litodactylus vel.* Redt., Faun. Austr. 777; *Eubrychius vel.* Thomson, Skand. Col. vii, 232.

A specimen collected at Detroit, Michigan, by Messrs. Hubbard and Schwarz, does not differ appreciably from the detailed descriptions above cited; it is rare in northern and middle Europe, on *Potamageton* and other plants, below the surface of the water. It is a small black insect, clothed with depressed greenish yellow scales; the prothorax has two broad dark stripes; the elytra are more thinly clothed with scales, except the sutural interspace, which is densely covered. The antennæ and legs are bright yellow, with the knees dusky. Length 2 mm.; .08 inch.

PELENOMUS Thomson.

The species of this genus are easily distinguished by the short stout beak, which they have in common with *Rhinoncus* and *Cœlogaster*, being combined with prosternum somewhat emarginate in front, but without antecoxal ridges. The eyes are round, convex, without orbital ridges, and are completely exposed in repose, on account of the entire absence of the postocular lobes of the prothorax. The claws are simple and moderately large. The funicle is 6-jointed, with the first joint longer and stouter; the club is rather large, oval-pointed, annulated and acuminate. There are but three species in my collection:

A. Funicle slender, 2d and 3d joints distinctly longer.
  Prothorax broadly sulcate, apical and posterior tubercles strongly marked, acute............... 1. **sulcicollis.**
B. Funicle shorter and stouter, joints 2–3 very little longer.
  Prothorax broadly sulcate, apical tubercles more distant but acute, posterior tubercles acute......... 2. **squamosus.**
  Apical tubercles indistinct; interspaces of elytra with rows of acute tubercles.................... 3. **cavifrons.**

1. **P. sulcicollis.** *Phytobius sulc.* Fahr., Sch. Curc. vii, 346.

Lake Superior to Georgia. The second and third joints of the funicle are distinctly longer than the following ones, and the upper margin of the eye is a little prominent, showing a tendency toward the second division of *Cœlogaster*.

2. **P. squamosus,** n. sp.

Smaller than *P. sulcicollis*, black, above densely clothed with dark gray scales, slightly mottled with brown, beneath with paler scales. Beak scarcely longer than the head, stout, cylindrical, densely and finely punctured; eyes convex, prominent, head densely punctured, not impressed. Prothorax wider than long, much narrowed in front, apical tubercles acute, distant, posterior tubercles acute, rather large; dorsal channel not deep, sides and dorsal stripe with paler scales. Elytra with deep slightly punctured striæ, interspaces convex, very finely rugose. Antennæ and legs more or less testaceous; the former rather stout, with large oval club;

Digitized by Google

second joint of funicle a little longer than the third, which is about equal to the fourth. Claws simple. Length 2 mm.; .08 inch.

Two specimens, New York and Michigan; three specimens, British Columbia; Crotch. The legs are testaceous in one, piceous in the others. The prosternum is broadly emarginate in front, and slightly concave, but without antecoxal ridges; the front coxæ are not widely separated. In the preceding species the prosternum is more deeply emarginate and more concave, though the front coxæ are not more widely separated.

3. **P. cavifrons**, n. sp.

Of the same size and form as *P. sulcicollis*, densely clothed with small pale and dark scales. Beak as long as the head, stout, cylindrical, curved, densely punctured; front strongly concave between the eyes. Prothorax wider than long, much narrowed in front, and deeply transversely impressed; apical margin elevated, notched at the middle, with approximate cusps; posterior tubercles large, acute; dorsal channel distinct. Elytra with rows of small, distant, acute tubercles on the third, fifth, seventh and ninth interspaces; striæ deep; antennæ and legs more or less testaceous; funicle with the second joint scarcely longer than the third or fourth. Front coxæ not more widely separated than in the other species. Length 2.2 mm.; .09 inch.

California, at S. Buenaventura, Los Angeles, and Lake Tahoe; Mr. Crotch. Though the front is deeply concave, and the upper margin of the eyes prominent, there is no distinct orbit, such as is seen in *Cœlogaster*.

CŒLOGASTER Sch.

This genus is easily distinguished from both *Rhinoncus* and *Pelenomus* by the eyes being inserted under distinct, acute, superciliary ridges or orbits, and being partly covered in repose. There are also important differences in the sternal pieces; the prosternum is still more deeply and suddenly emarginate in front, so as to reach almost to the front coxæ, which also reach almost to the hind margin, and are more widely separated than in either of the genera just named; the ridges in front of the coxæ limiting the pectoral groove, are much stronger. The mesosternum is truncate behind at the middle, and enters less into the formation of the middle coxal cavities. The intercoxal process of the metasternum is therefore almost square, and the middle coxæ are more posterior than in the other genera.

The beak and claws vary according to species; the funicle is 6-jointed, the first joint being stouter, and the others slender; second and third elongate; 4–6 shorter, equal, scarcely thicker, club elongate-oval, pubescent, acute at tip.

Three species are known to me, of which the first is the type of the genus.

A. Beak slender, claws cleft; eyes nearly covered in repose.
  Black, mottled with whitish pubescence; elytra
    with a common cruciform white mark at base;
    antennæ, tibiæ and tarsi testaceous.......... 1. **Zimmermanni.**

Digitized by Google

B. Beak stout, claws simple; eyes nearly entirely exposed.

Black, clothed with fine brown pubescence; antennæ and legs dark testaceous...............	2. **cretura.**
Brown, with some small white spots............	3. **obscurus.**

1. **C. Zimmermanni** Gyll., Sch. Curc. iv, 580.

South Carolina and Georgia. The beak in this species is nearly as long as the prothorax, and is only about one-quarter as wide as its length. The supraocular ridges are less developed than in the two other species. The postocular lobes are very broad and nearly conceal the eyes in repose.

2. **C. cretura.** *Curculio cretura* Herbst, Käfer, vii, 70; pl. 100, f. 5; *Ceutorhynchus cret.* Say, Curc. 20; ed. Lec. i, 285; *Falciger 4-spinosus* Say, Journ. Ac. Nat. Sc. Phil. iii, 310; ed. Lec. ii, 173. *Phytobius 4-spin.* Gyll., Sch. Curc. iii, 463.

Broadly ovate, black, above thinly clothed with brown pubescence, beneath at the sides covered with pale brown scales, extending upon the sides of the prothorax. Head punctured, broadly impressed between the eyes; finely carinate behind, supraorbital ridges strong; beak rather stout, curved, as long as the head, finely punctured. Prothorax wider than long, strongly narrowed in front, densely punctured, middle of base deeply impressed; the two apical denticles are acute and distant; the posterior or lateral tubercles are also large and acute. Elytra with deep striæ, which are punctured at the bottom; interspaces not much wider than the striæ near the suture, but becoming wider externally, densely rugose. Beneath densely coarsely punctured, antennæ and legs brown; claws not toothed. Length 2.8 mm.; .11 inch.

Middle and Western States. Of the same size, form and sculpture as *C. Zimmermanni*, but quite distinct by the shorter beak, simple claws, unvariegated pubescence, and not channeled prothorax. It is perhaps worthy of being separated with the next species, as a distinct genus, on account of the eyes being almost entirely exposed in repose, while in *C. Zimmermanni* they are nearly covered.

3. **C. obscurus**, n. sp.

Broadly oval, reddish brown, head darker, strongly punctured, deeply impressed; supraorbital ridges strong; beak very stout, not longer than the head, more finely punctured. Prothorax wider than long, much narrowed in front, coarsely punctured, channeled; apical denticles acute, distant, posterior tubercles acute. Elytra with a few small spots of white hairs; striæ deep, strongly punctured; interspaces but little wider, convex, finely rugose and finely scaly. Beneath coarsely punctured, clothed with pale scales. Antennæ and legs testaceous, claws not toothed. Length 2.8 mm.; .11 inch.

Florida; Dr. E. Brendel, and Messrs. Hubbard and Schwarz. Of the same form and size as the preceding, but with shorter and stouter beak; more coarsely punctured, and rather deeply channeled prothorax.

Digitized by Google

RHINONCUS Sch.

The species of this genus have the broad stout form usual in the tribe, and only differ from *Pelenomus* by the prosternum being deeply emarginate in front, with distinct antecoxal ridges.

The middle coxæ are normal in position, their cavities being formed equally by the meso- and metasternum, whereby it differs notably from *Cœlogaster*; it also differs from that genus by the eyes, which are rounded and convex, as in the other genera, and without any trace of superciliary ridge.

The funicle of the antennæ is 7-jointed, and the claws cleft are in our species.

1. R. **pericarpius** Gyll., Sch. Curc. iv, 582; *Curculio peric.* Linn., Syst. Nat. 12th, ii, 609; Fabr., Ent. Syst. i, 2d, p. 408; et auctorum plurimorum; *Ceutorhynchus triangularis* Say, Curc. 20; ed Lec. i, 286.

Abundant in Europe; Lake Superior, Indiana, Pennsylvania, Kansas; easily known from our other Ceutorhynchoids by the larger size and conspicuous elongate sutural white spot at the base of the elytra. The prothorax is very coarsely punctured, feebly channeled, and the lateral tubercles are not very distinct. Length 4 mm.; .16 inch. I do not know why Gemminger and Harold have referred Say's description to *Phytobius*.

2. R. **pyrrhopus** Boh., Sch. Curc. viii, 2d, 172.

Middle and Western States, to Colorado. Smaller, clothed above with coarser brown pubescence, and beneath with white scales. The prothorax is feebly channeled, and the lateral tubercles are acute. The antennæ and legs are fulvous yellow. The elytra are marked with a similar elongate basal white or yellowish spot, which, however, is sometimes not very apparent. Length 2.3 mm.; .09 inch.

3. R. **longulus**, n. sp.

Elongate, black or dark brown, thinly clothed with small white scales; more dense, forming a short posterior dorsal line on the prothorax, and an elongate sutural spot at the base of the elytra. Head and beak densely punctured, the latter stout, not longer than the head. Prothorax not wider than long, slightly narrowed in front, feebly rounded on the sides, coarsely and densely punctured; slightly channeled near the base; tubercles entirely wanting. Elytra wider than the prothorax, elongate-oval, convex, humeri oblique; striæ deep, punctured, interspaces flat, densely rugose. Antennæ and tarsi testaceous. Length 2.5 mm.; .10 inch.

Southern and Western States; Florida to Illinois; Gilroy, California. Remarkable for its elongate form, and the absence of prothoracic tubercles. The eyes are round, and barely touch the prothorax in repose. The antecoxal ridges are very strong, but the prosternum is hardly emarginate in front.

Tribe XIX. BARINI.

An important type of *Curculionidæ*, containing numerous genera and groups, of which only a few are represented in our fauna. It is in this

Digitized by Google

tribe that the nearest approach to *Calandridæ* and *Cossonidæ* is made, in form and general appearance, though the family characters are quite different.

The following characters will enable them to be distinguished from the other tribes in which the front coxæ are separate.

Beak not received closely upon the sternum, which however is sometimes broadly sulcate in front of the anterior coxæ; when this groove does not exist, there are sometimes seen (*Madarus*) two short approximate ridges, limited inwards by an impressed line, which may be regarded as the last remnant of the pectoral groove. In other cases (*Baris striatus*) even these lines disappear, and the merest trace of a concavity remains in the apical constriction of the prothorax, which in all the species is not emarginate beneath, and is destitute of postocular lobes. In many others even this slight concavity or flattening is wanting, and the apical part of the prothorax is altogether cylindrical, above and beneath. The meso- and metasternum are closely united, and the suture between them is frequently obliterated. The side-pieces of the mesothorax are so extended outwards and upwards, that they intervene strongly between the base of the prothorax and the elytra The sides of the latter, therefore, become obliquely truncated, giving a form not observed in any of the preceding tribes. The other characters are somewhat variable. The pygidium is sometimes exposed, sometimes covered. The claws are simple, and either divergent, connate, or even (*Barilepton*) single.

The genera in our fauna represent two groups:

Pygidium exposed, usually vertical; fifth ventral segment in the latter case truncate or subemarginate........	**Barides.**
Pygidium oblique or horizontal, not fully exposed; fifth ventral segment rounded at tip.....................	**Centrini.**

Group I. **Barides.**

The separation between this group and the *Centrini* is not very definite, though characters such as the perpendicular pygidium, and the shorter and stouter beak, seen in most of the species, do not occur in the last named group. The main character to be relied on, in the absence of the easily recognized habitus, is that the elytra are more broadly separately rounded at tip, and the pygidium thus becomes more exposed.

Pygidium oblique; fifth ventral segment longer, rounded at tip; outer joints of funicle but little broader, club large, elongate-oval, pubescent....	2.
Pygidium vertical; fifth ventral segment shorter, subtruncate......................................	3.
2. Beak long, slender, straight......................	ORTHORIS.
" shorter, less slender, curved...............	RHOPTOBARIS.
3. Club annulated, entirely pubescent..............	4.

Digitized by Google

	Club with first joint larger, shining, claws divergent....................................	**BARIS.**
4.	Claws approximate, frequently connate......	**5.**
	" divergent, larger, last joint of tarsi longer than usual................	**7.**
5.	Front coxæ widely distant, body nearly glabrous....................................	**6.**
	Front coxæ not widely distant; body densely scaly....................................	**TRICHOBARIS.**
6.	Prothorax strongly constricted near the tip...	**8.**
	" feebly " " " ...	**PSEUDOBARIS.**
7.	Second joint of funicle not longer than third..	**ONYCHOBARIS.**
	" " " longer...............	**AULOBARIS.**
8.	Front thighs not toothed....................	**AMPELOGLYPTER.**
	" " obtusely toothed...............	**MADARUS.**

ORTHORIS n. g.

This genus contains a sparsely pubescent species from California, which has a singular resemblance in form to *Orchestes*. It differs from the other genera of this subtribe by the beak being long, slender, cylindrical and not curved; it is separated from the front by a transverse impression, as usual. The antennæ are inserted about two-fifths from the end of the beak, the scape does not quite reach the eyes; the first joint of the funicle is stouter and longer than the others, which are nearly equal; the club is elongate-oval, as long as the joints 2–7 of the funicle, and entirely pubescent and sensitive. The front coxæ are nearly contiguous and the prosternum is broadly, though not deeply sulcate in front. The legs are rather long and slender, tibiæ not mucronate at tip; the third joint of the tarsi broad and deeply bilobed; claws simple, divergent. The prothorax is as long as wide, gradually narrowed in front, with sides perfectly straight. Elytra wider at base than the prothorax, humeri prominent, sides parallel, tips separately rounded. pygidium exposed, obliquely declivous; fifth ventral longer than the preceding, acutely rounded at tip.

1. **O. Crotchii**, n. sp.

Elongate, not convex above, black, moderately shining, sparsely pubescent with rather coarse whitish hairs. Beak slender, cylindrical, nearly straight, longer than the head and prothorax, sparsely punctulate towards the tip, more strongly towards the base; head convex, sparsely punctulate, frontal constriction deep. Prothorax as long as wide, regularly narrowed from base to tip, which is only one-half as wide as the base; sides straight, disc strongly and rather densely punctured, with a narrow smooth dorsal line. Elytra one-fourth wider at base than the prothorax, humeri prominent, rounded, sides parallel, tip rounded; striæ deep, impunctured, interspaces slightly convex, sparsely punctulate. Beneath strongly punctured, punctures becoming gradually finer upon the abdomen. Length 3.5 mm.; .14 inch.

Digitized by Google

California, locality unknown; several specimens, without sexual differences.

RHOPTOBARIS n. g.

The single species of this genus resembles closely in form, sculpture and pubescence *Trichobaris trinotata*, but without the three denuded spots at the base of the prothorax. It differs by the club of the antennæ almost as long as the funicle, elongate-oval, entirely pubescent, and very indistinctly annulated; the first joint of the funicle is as long as the three following, and stouter; 2–7 short, gradually a little broader. Beak as long as the head and prothorax, curved, not very slender, depressed as usual at tip, frontal constriction not deep. Front coxæ moderately distant, prosternum not impressed nor sulcate. Elytra elongate oblong, separately rounded at tip; pygidium exposed, obliquely declivous. Last ventral segment as long as the third and fourth united, rounded at tip, with a slight tooth at the middle in ♂, as in *Trichobaris*. Legs slender, tibiæ with a very small apical hook; third joint of tarsi moderately dilated, bilobed; last joint long, claws rather large, divergent.

1. **R. canesens**, n. sp.

Oblong elongate, very densely and rather finely punctured, and clothed with brownish gray pubescence, or hair-like scales. Head finely punctured; beak not stout, finely punctured, nearly smooth at the tip. Prothorax scarcely longer than wide, gradually but not strongly narrowed from the base, sides broadly rounded, base broadly subsinuate, truncate in front of the scutellum. Elytra a little wider than the prothorax, striæ well marked; interspaces wide, flat, densely and rugosely punctured. Punctures of under surface a little coarser than above. Length 4 mm.; .16 inch.

Colorado, four specimens.

TRICHOBARIS n. g.

I have separated as a distinct genus, certain species of elongate form and densely clothed with scales or pubescence. They differ from other genera of the group by the following characters: Club of antennæ rather small, oval, entirely pubescent, first joint forming about one-half of the mass. The funicle is stout, first joint longer, others equal in length, but gradually broader. Beak as long as the prothorax, much curved, rather stout, quite gibbous at base, frontal constriction deep. Elytra separately rounded at tip. Pygidium vertical; last ventral segment scarcely longer than the fourth; with a small apical cusp in ♂. Front coxæ very narrowly separated, prosternum broadly concave, and subsulcate in front of the coxæ. Legs slender, tibiæ with moderate apical hook; tarsi with third joint moderately dilated, bilobed, last joint long, claws approximate and connate at base.

Scales of upper surface hair-like........................ **2.**
" " " oval; prothorax without denuded basal spots.. **1. texana.**

Digitized by Google

2. Pubescence dense; prothorax with three denuded basal spots.................................... **2. trinotata.**
Pubescence thin, prothorax without spots............ **3. plumbea.**

1. **T. texana,** n. sp.

This species in every respect resembles the next, except in being clothed with a dense covering of whitish scales, which on the upper surface are not hair-like, but oval, and not more than three times longer than wide. Beneath the scales are of the same size as above, and a little broader. The scutellum is concave, black, naked, and shining. There is a very small denuded basal spot, just inside of the humeral callus, but it does not extend upon the prothorax; the striæ are fine, and almost concealed by the covering of scales. Length 5 mm.; .20 inch.

Texas, Belfrage. As in the next species, the third and fourth ventral segments are smooth and shining at the middle.

2. **T. trinotata** Say, Curc. 17; ed. Lec. i, 280 (*Baridius*); Lec., Proc. Acad. Nat. Sc. Phila. 1868, 364; *Baridius vestitus* Boh., Sch. Curc. iii, 718; var. *B. mucoreus* Lec., Pr. Ac. 1858, 79; *ibid*, 1868, 364.

Atlantic district, abundant and sometimes injurious to potatoes.

Specimens from Upper and Lower California, and Arizona, are of larger size, and the proportion of oval scales on the under surface is greater; intermediate forms between these and the northern individuals, in which the vestiture of the under surface is almost entirely capillary, occur in the Southern States.

3. **T. plumbea** Lec., Proc. Acad. Nat. Sc. Phila. 1868, 364 (*Baridius*). Maryland, one specimen. Much smaller than *B. trinotata*, more finely and less densely pubescent above and beneath, with the scales oval only upon the flanks of the prothorax; there are no denuded basal spots. The elytral striæ are deeper. Length 3 mm.; .12 inch.

AULOBARIS n. g.

I have separated as a distinct genus some specimens from the Atlantic slope, which differ from *Baris* proper by the more slender antennæ; the first joint is scarcely stouter than the second, and the latter is quite as long as the first; the remaining joints (3–7) are gradually slightly wider and the club is elongate-oval, uniformly pubescent except at the base of the first joint, and not large. The beak is longer than the prothorax, cylindrical, slightly compressed towards the base, and not very slender. The front coxæ are rather widely distant, and the prosternum is deeply and broadly sulcate in front.

The body is more convex than usual in *Baris*, though in this respect, the species resemble *Pseudobaris farcta*. The under surface is coarsely punctured, with a small white hair in each puncture.

These species represent group B of my synoptic table in Proc. Ac. Nat. Sc. Phil. 1868, 364, and may be distinguished as follows:

Digitized by Google

Brown, sides of prothorax broadly rounded........	1. scolopax.
Black, " " strongly "	2.
2. Prothorax coarsely, less densely punctured.........	4. anthracina.
" less coarsely and more densely punctured	3.
3. Elytral interspaces transversely rugose and punctulate......................................	2. ibis.
Elytral interspaces with single rows of punctures...	3. naso.

1. **A. scolopax** (Say), Curc. 26; ed. Lec. i, 295, (*Baridius*); Boh., Sch. Curc. iii, 699.

Illinois and Georgia, four specimens; in three of them distinct traces of a smooth dorsal line are seen on the prothorax, but in one the surface is quite uniformly punctured. The elytra become gradually wider behind the base for a short distance, so that the humeri are distinct, though very obtuse.

2. **A. ibis** Lec. loc. cit. 365.

Georgia, four specimens. More convex than the preceding and very similar in form to *Pseudobaris farctus*. The humeri are rounded, slightly prominent.

3. **A. naso** *Baridius nasutus* Lec. loc. cit. 295.

One specimen, Kansas, and two from California or Arizona. The elytra are not wider than the prothorax, the striæ are deeper, the interspaces narrower, and each is marked with a line of deep punctures; at the base of the third and fifth interspaces are a few whitish hairs.

I regret to have been the cause of confusion by having previously described another *Baridius nasutus* from Tejon, Cal., (Pr. Ac. Nat. Sc. Phil. 1859, 79). On reexamining that species I found that as the pygidium was covered by the elytra it did not belong to *Baris*; though I inadvertently forgot the name I had given to the species at the time I prepared the synopsis of *Baridius*, in consequence of having transferred it to another box with the other species of *Centrinus*.

4. **A. anthracina** (Boh.), Sch. Curc. iii, 727 (*Baridius*).

Oblong oval, shining, black, head less shining, finely punctured, beak as long as the prothorax, rather slender, moderately curved, finely punctured above, coarsely punctured at the sides; club of antennæ rounded oval, shining only at the base. Prothorax coarsely and deeply punctured, more densely at the sides, which are nearly parallel for two-thirds the length, then suddenly rounded and narrowed to the apex, which is constricted at the sides; dorsal line wanting. Elytra with deep striæ, interspaces moderately wide, flat, each with a row of shallow punctures, extending across the interspaces, as distinct rugæ. Prosternum deeply sulcate, with the groove sharply defined and nearly smooth. Length 3.8 mm.; .15 inch.

One specimen from Florida; Messrs. Hubbard and Schwarz. This species has the rather flat upper surface of true *Baris*, and is quite different in form from the other three above mentioned.

Digitized by Google

BARIS Germ.

As I have here restricted this genus, it contains only those species in which the club of the antennæ is small, nearly round, with the first joint not sensitive, shining, and constituting more than one-half the mass. The claws are separate, divergent, and of moderate size, and in some of the species (*sparsa*, &c.) small. The beak is stout, usually short, and much curved; the frontal constriction rather deep; sometimes it is a little longer than the prothorax. The front coxæ are never very widely separated; the prosternum is flat or broadly sulcate according to species. The pygidium is vertical, and the fifth ventral is but little longer than the fourth. Tibiæ strongly mucronate at tip. The species are glabrous or very slightly and sparsely pubescent.

	Prosternum narrow between the coxæ...........	2.
	" moderately wide....................	4.
2.	Prothorax gradually rounded on sides..........	1. **strenua.**
	" more suddenly rounded in front and constricted................................	3.
3.	Humeral callus less prominent.................	2. **umbilicata.**
	" " more prominent................	3. **striata.**
4.	Prosternum flat, or feebly concave	5.
	" broadly subsulcate.................	6.
5.	Form narrow, nearly glabrous..................	11.
	" oval, nearly glabrous.....................	4. **subovalis.**
	" oblong, nearly glabrous..................	5. **transversa.**
	" " pubescent, more finely and densely punctured.................................	15. **pruinosa.**
6.	Pectoral groove coarsely punctured............	7.
	" " sparsely punctured, color brassy, claws smaller..............................	9.
7.	Color slightly brassy..........................	8.
	" black..................................	6. **carinulata.**
8.	Interspaces irregularly punctulate.............	7. **subænea.**
	" with regular rows.................	8. **tumescens.**
9.	Narrower......................................	10.
	Stouter, prothorax very coarsely and sparsely punctured.................................	9. **nitida.**
10.	Prothorax more feebly punctured..............	10. **interstitialis.**
	" " strongly and densely punctured	11. **confinis.**
	" " " " sparsely "	12. **ærea.**
11.	Prothorax rather sparsely punctured............	13. **sparsa.**
	" densely "	14. **macra.**

1. **B. strenua** (Lec.), Pr. Ac. Nat. Sc. Phil. 1868, 363, (*Baridius*).

Wisconsin, Kansas, New Mexico. This species resembles in form and sculpture *B. carinulatus* and others in that neighborhood, but is easily known by the prosternum being narrow between the coxæ, and flattened

Digitized by Google

but not concave in front of them. The head is nearly smooth, the beak coarsely punctured, short and curved; the club of the antennæ is round, with first joint shining. Prothorax ample, rounded on the sides, more suddenly narrowed and feebly constricted in front; punctures of usual size, smooth dorsal line distinct. Elytra very little wider than prothorax, striæ very deep, interspaces elevated, flat, each with a row of strong punctures, which are approximate and furnished with very small white hairs, more obvious than in any of the following species; they are somewhat confused on the third interspace.

2. **B. umbilicata** (Lec.), Pr. Ac. Nat. Sc. Phil. 1868, 363, (*Baridius*). Two specimens, Pennsylvania. This species resembles the next in every respect except that the prothorax is comparatively larger, and the humeral callus of the elytra less prominent. The head is sparsely, the beak strongly punctured, the club of the antennæ nearly round, with the first joint shining. Prothorax narrowed in front from the base, and scarcely rounded for two-thirds the length, then suddenly rounded and constricted near the tip; punctures unusually large, umbilicated. Elytra a little wider than prothorax at base, striæ very deep, interspaces narrow, elevated, flat, each with a row of strong not approximate punctures. Prosternum very narrow between the coxæ, broadly concave and coarsely punctured in front of them. Beneath coarsely punctured, finely sparsely pubescent. Length 5 mm.; .20 inch.

3. **B. striata** (Say), Curc. 17; ed. Lec. i, 281; Lec. Pr. Ac. 1868, 362. Michigan, Illinois, Kansas, Arizona. This is one of our largest species and is easily recognized by the comparatively smaller prothorax, and more prominent humeral callus. The prosternum is very narrow between the coxæ, flat and coarsely punctured in front of them. The antennal club is nearly round and the first joint is shining. Length 5.5–6.5 mm.; .22–.26 inch.

4. **B. subovalis** (Lec.), Pr. Ac. Nat. Sc. Phil. 1868, 363, (*Baridius*). One specimen; Wisconsin. A rather large species of oval form, and shining black color. Head very convex, sparsely punctulate; beak a little longer and less stout than in the following eight species, much curved, constricted at base, strongly punctured. Prothorax narrowed from the base forwards, then more suddenly rounded and narrowed to the tip, which is slightly constricted at the sides; punctures strong, but not very coarse, more dense at the sides, dorsal line distinct. Elytra scarcely wider than the prothorax, humeri rounded, not prominent; striæ deep, interspaces flat, finely but distinctly punctulate, punctures of the third interspace confused, of the others in irregular rows. Prosternum uniformly coarsely punctured, longitudinally concave or broadly sulcate in front; front coxæ moderately distant. Antennæ with club nearly round and first joint shining. Length 6 mm.; .24 inch.

5. **B. transversa** (Say), Curc. 18, (*Baridius*); ed. Lec. i, 282; Lec., Pr. Ac. Nat. Sc. Phil. 1868, 362; *B. quadratus* Lec., ibid. 361.

Digitized by Google

Illinois to Kansas. Body oblong, rather elongate; head feebly punctulate, beak rather finely punctured, short, stout and much curved; frontal constriction not deep. Prothorax wider than long, subquadrate, very slightly narrowed from the base for three-fourths the length, then suddenly narrowed to the tip, which is scarcely impressed at the sides; punctures coarse, dense, smooth dorsal line narrow, sometimes obsolete. Elytra with deep striæ, interspaces flat, strongly and confusedly punctured, forming here and there transverse rugosities. Prosternum densely and coarsely punctured, flattened and slightly concave in front, but not sulcate; front coxæ moderately distant, antennæ as usual. Length 4.5 mm.; .18 inch.

6. B. **carinulata** (Lec.), Pr. Ac. Nat. Sci. Phil. 1858, 79; ibid. 1868, 362, (*Baridius*).

One specimen, Texas. Closely allied to the last, but the dorsal line of the prothorax is more distinct, and the punctures of the elytra are irregular only on the second and third interspaces, and form regular rows on the others. The prosternum is longitudinally concave, and subsulcate, though the limits of the groove are not well defined; the punctures are also less dense.

7. B. **subænea** (Lec.), Pr. Ac. Nat. Sc. Phil. 1868, 361, (*Baridius*).

Middle States. The color is brassy black, the beak more strongly punctured. the prothorax not wider than long, coarsely and densely punctured, with faint dorsal line. Elytra with deep striæ, interspaces confusedly punctured. Prosternum very coarsely punctured, broadly subsulcate. Length 4.5 mm.; .18 inch.

8. B. **tumescens** (Lec.), Pr. Ac. Nat. Sc. Phil. 1868, (*Baridius*).

New York, Illinois, Louisiana, Texas. A brassy species of oblong form, almost like *B. transversa*, with the prothorax coarsely punctured, and dorsal line obsolete; the beak is finely punctured. Elytra with deep striæ, interspaces narrow, each with a row of fine punctures, which are confused upon the third. Prosternum coarsely punctured, broadly subsulcate. Length 4–4.5 mm.; .16–.18 inch.

9. B. **nitida**, n. sp.

Oblong-oval, shining black with a bronze tint. Head convex, scarcely perceptibly punctulate; beak short, stout, curved, finely punctured, frontal constriction well marked. Prothorax not wider than long, gradually narrowed from the base for two-thirds the length, then rounded and more suddenly narrowed to the tip, which is not at all impressed on the sides; disc very coarsely but sparsely punctured, without trace of smooth dorsal line. Elytra scarcely wider than prothorax, striæ deep, interspaces rather wide, each with a single series of well impressed distant punctures. Prosternum at the middle broadly but distinctly sulcate and sparsely punctured; flanks broadly concave, so that the lateral edge is somewhat distinct; front coxæ moderately distant. Antennæ as usual. Length 4.6 mm.; .18 inch.

One specimen, Florida; Dr. Edward Palmer. Very distinct from all

Digitized by Google

others in our fauna. I observe in this and the three following species a peculiarity, which is extremely rare among *Curculionidæ*, and in fact among *Rhynchophora*; the flanks of the prothorax are very suddenly inflexed, and slightly concave, so that the side margin, though not well defined by a sharp line, is still distinctly indicated.

10. B. **interstitialis** (Boh.), Sch. Curc. iii, 684, (*Baridius*); ? (*Rhynchænus int.*) Say, Journ. Acad. Nat. Sc. Phil. iii, 314; ed. Lec. ii, 176; *Baridius int.* Say, Curc. 18; ed. Lec. i, 282.

Middle and Southern States. I have retained this name for a species which is quite distinct from all others in our fauna. The well marked structural characters which enable our species of *Baris* to be easily separated, were, however, not perceived by Say, nor by the collaborators of Schönherr, and I am therefore doubtful if the present name should be preserved. As far as I can judge from the descriptions, this species is the one intended by Boheman, founded upon a typical specimen from Florida sent by Say, and on others from South America. But I am very uncertain if it be the one originally described by Say, and quite doubtful if that original be the same with the one subsequently referred to (Curc. 18), of which it is said that the punctures of the elytral interspaces "have a transverse rugulous appearance." In the original description (J. Ac. iii, 314), these same punctures are declared to be orbicular.

Head sparsely punctulate, beak finely punctured, frontal constriction strong; prothorax strongly but not densely punctured, scarcely wider than long, slightly narrowed from the base for two-thirds the length, then more suddenly rounded and narrowed to the tip, which is feebly impressed at the sides. Elytra with deep striæ, interspaces flat, each with a row of very fine punctures, somewhat confused on the third interspace, and nearly obsolete in some specimens. Prosternum at the middle broadly but rather deeply sulcate, and more sparsely punctured. Antennæ as usual. Length 3.3 mm.; .13 inch.

The color is black, slightly bronzed.

11. B. **confinis** (Lec.), Pr. Ac. Nat. Sc. Phil. 1868, 362, (*Baridius*).

Atlantic States, to Kansas. Very closely related to *B. interstitialis*, but more brassy, smaller and a little narrower, with the punctures of the prothorax larger and less distant. The punctures of the interspaces, though fine, are distinct, and arranged in rows, those of the third interspace are not confused. Length 3 mm.; .12 inch.

12. B. **ærea** (Boh.), Sch. Curc. viii, 1st, 141, (*Baridius*); Lec., Pr. Ac. Nat. Sc. Phil. 1868, 362.

Southern States. Narrower, usually smaller, brighter brassy, with the punctures of the prothorax strong, but less dense, and those of the elytral interspaces extremely small and distant, placed in single rows. Length 2.5–3.3 mm.; .10–.13 inch.

13. B. **sparsa** (Lec.), Pr. Ac. Nat. Sc. Phil. 1868, 364, (*Baridius*).

Oregon and California, three specimens. Though the prosternum is

Digitized by Google

nearly flat, and coarsely punctured in this species, I have thought it better to separate it from *B. subovalis* and *transversus* on account of the narrower form, which approaches that of *B. ærea*. The prothorax is however more regularly rounded on the sides, and is fully as long as wide; the punctures are coarse but not dense. The elytral striæ are less deep than usual and the punctures of the interspaces are well marked; these punctures are finer and more distant in the specimen from Oregon, than in those from California. The latter being better preserved show fine but distinct white hairs proceeding from each interstitial puncture. The thoracic smooth dorsal line is very distinct in the Californian, but almost obsolete in the Oregon specimen. A larger series of specimens will show that these differences are individual rather than specific. Length 3 mm.; .12 inch.

14. **B. macra** (Lec.), Pac. R.R. Expl. and Surv. Ins. 58, (*Baridius*); Pr. Ac. Nat. Sc. Phila. 1868, 362.

San Francisco, Cal., three specimens. Nearly related to *B. sparsa*, and of the same narrow form. The prothorax is however more densely punctured, without dorsal smooth line. The punctures of the interspaces of the elytra are very small, and upon the third are somewhat confused. Prosternum between the coxæ not very wide, slightly longitudinally concave, but scarcely subsulcate. Length 3.5 mm.; .14 inch.

15. **B. pruinosa**, n. sp.

Rather robust, oval-subquadrate, black, pruinose with small narrow white scales, some of which are hair-like. Head naked, nearly smooth; beak shorter than prothorax, stout, curved, punctured, pubescent, constricted at base. Prothorax scarcely longer than wide, gradually narrowed from the base for two-thirds the length, then more rapidly to the tip, which is constricted on the sides; disc densely but not coarsely punctured, scutellar lobe larger than usual, emarginate; dorsal line indistinct, or wanting. Elytra gradually a little wider than the prothorax, striæ deep, interspaces flat, wide, densely punctured. Beneath densely punctured. Front coxæ moderately separated, prosternum slightly concave, not sulcate. Club of antennæ nearly round, with first joint slightly pubescent, but shining. Length 4.5 mm.; .18 inch.

Texas, Belfrage, not rare. The third joint of the tarsi is broader than usual, and the claws larger, thus showing a transition towards *Onychobaris*, but the club of the antennæ is of the present genus.

ONYCHOBARIS n. g.

Under this name I would group those species in which the club of the antennæ is more oval, entirely sensitive and pubescent, the first joint forming less than one-half the mass; the second joint of the funicle not longer than the third; and the claws divergent and larger than usual.

In other respects this genus agrees with *Baris*, and the species may be classified similarly, though the front coxæ are usually much more widely separated than in *Baris*.

Digitized by Google

Interspaces of elytra with rows of punctures..........	2.
Interspaces of elytra densely punctured, and thinly pubescent..	1. densa.
2. Prosternum very wide between the coxæ............	3.
" moderately wide between the coxæ.......	5.
3. Black, glabrous, or nearly so.........................	4.
Dull black, finely pruinose..........................	2. subtonsa.
4. Prothorax without smooth dorsal line................	3. pectorosa.
" with broad dorsal line.....................	4. distans.
Much smaller and narrower..........................	5. seriata.
5. Sparsely pubescent; very coarsely cribate............	6. cribrata.
Prothorax plicate, elytra with pattern of large narrow scales..	7. rugicollis.

1. **O. densa** (Lec.), Pr. Acad. Nat. Sc. Phil. 1859, 79; *ibid.* 1868, 362. San Diego, Cal., three specimens. Broader and less finely pubescent than *O. subtonsa*, with the prothorax more coarsely punctured and subcarinate; it is gradually narrowed in front from the base for two-thirds the length, then rapidly narrowed to the apex, which is distinctly constricted. Head punctured in front, smooth behind. Striæ of elytra deep, interspaces flat, irregularly punctured. Beak as long as prothorax and not stout; club of antennæ oval, entirely pubescent and sensitive. Front coxæ widely separated, prosternum flat, densely and coarsely punctured. Length 4 mm.; .16 inch.

2. **O. subtonsa**, n. sp.

Less robust, dull black, pruinose with very fine whitish pubescence, more evident on the elytra than on the prothorax. Head punctured in front, nearly smooth behind, beak longer than in the preceding. Prothorax scarcely wider than long, sides parallel for two-thirds the length, then rapidly narrowed and rounded to the apex, which is feebly constricted at the sides: disc densely punctured, each puncture with a small hair at the bottom; antescutellar lobe broad, not emarginate. Elytra scarcely wider than the prothorax, striæ deep, interspaces flat, each with a row of small punctures. Front coxæ widely separated; prosternum nearly flat. Length 4 mm.; .16 inch.

Texas, Belfrage, one specimen.

3. **O. pectorosa**, n. sp.

Ovate, narrower behind, black, nearly glabrous above. Head sparsely punctulate; beak as long as the prothorax; rather slender, punctulate, much curved at base, frontal constriction deep. Prothorax larger than usual, wider than long, slightly narrowed from the base for two-thirds the length, then rapidly narrowed to the tip, which is constricted at the sides; disc rather closely but not coarsely punctured; scutellar lobe more prominent than usual, truncate. Elytra at base not wider than prothorax, gradually narrowed behind; striæ deep, interspaces flat, each with a row of

strongly marked punctures. Prosternum very wide between the coxæ, coarsely punctured, with two slight longitudinal impressions in front. Length 4 mm.; .15 inch.

Texas, Belfrage, one specimen.

4. **O. distans** (Lec.), Pr. Ac. Nat. Sc. Phil. 1868, 363, (*Baridius*).

New Mexico, Fendler, one specimen. Oval subquadrate, black, scarcely shining, glabrous. Head sparsely punctulate; beak punctulate, as long as the prothorax, not stout, regularly and strongly curved, frontal constriction feeble. Prothorax suddenly narrowed, rounded on the sides in front, and constricted at the sides near the tip; punctures distant on the disc, more dense towards the sides; smooth dorsal line very distinct. Elytra with deep striæ, interspaces flat, rather wide, with rows of shallow distant punctures, which are more evident than usual. Prosternum very wide between the coxæ, coarsely and sparsely punctured, broadly concave in front, with two small impressions. Length 3.3 mm.; .13 inch.

5. **O. seriata** (Lec.), Pac. R. R. Expl. and Surv. Ins. 58; Pr. Ac. Nat. Sc. Phil. 1868, 363, (*Baridius*).

San Francisco, Cal.; one specimen. A small, shining black species of narrow form, resembling in this respect the next, as well as *Baris sparsa*, and *Pseudobaris angusta*. From the last two it is easily distinguished by the generic characters; from *O. macra* it is readily known by the more distant front coxæ. The prosternum is as wide as in the two preceding species, flat and coarsely punctured, without impressions. The third joint of the tarsi is less broadly dilated.

Head dull, feebly punctulate; beak as long as the prothorax, not stout, rugosely punctured, regularly curved, frontal constriction faint. Prothorax scarcely longer than wide, sides rounded in front, and scarcely constricted; punctures strong, and dense, without smooth dorsal line. Elytra with rather narrow striæ, interspaces flat, each with a row of small distant punctures. Length 2.5 mm.; .10 inch.

6. **O. cribrata**, n. sp.

Elongate, brownish black, shining, sparsely clothed with rather coarse white reclinate hairs. Head smooth, beak short, not longer than the prothorax, stout, curved, punctured, strongly constricted at base. Prothorax quadrate, wider than long; sides parallel, suddenly narrowed and rounded near the tip; very coarsely punctured, and smooth dorsal line narrow, but distinct. Elytra a little wider than the prothorax, sides parallel, rounded at the tip, striæ deep, interspaces narrow, each with a row of rather distant small punctures, from which proceed white hairs. Beneath coarsely punctured, punctures becoming smaller and distant upon the abdomen. Length 3.3 mm.; .125 inch.

Texas, Belfrage, two specimens. The front coxæ are moderately distant, as in most of the glabrous species; the prosternum is slightly concave. The club of the antennæ is short oval, and the first joint constitutes more than one-half the mass and is somewhat shining. In the best preserved

Digitized by Google

specimen the pubescence is more dense at the third interspace, and on the second to the fifth interspaces for a short distance behind the middle.

7. **O. rugicollis**, n. sp.

Oblong oval, brownish-black, above with scattered elongate yellow scales, which on the elytra form an indefinite pattern of a transverse band at the base, and another just behind the middle connected by some less densely placed scales. Head convex, nearly smooth, beak as long as the prothorax, attenuated towards the tip, strongly curved, punctured, frontal constriction deep. Prothorax wider than long, feebly narrowed from the base for two-thirds the length, rounded on the sides, slightly constricted near the tip; very deeply and coarsely rugose, leaving narrow elevated folds, much as in *Rhyssematus*; there are a few scattered yellow hair like scales; base scarcely sinuate. Elytra a little wider at base than the prothorax, gradually narrowed behind, scarcely separately, but almost conjointly rounded at tip; striæ deep, interspaces flat, each with a row of small distant punctures. Prosternum very broad between the coxæ, coarsely punctured, marked in front with two lines converging behind, and enclosing a smooth triangular space. Club of antennæ small, oval rounded, pubescent; claws divergent. Length 4.2 mm.; .17 inch.

Middle and Southern States. The pygidium is less exposed than usual, but is perpendicular, so that this species cannot be confounded with *Centrinus*, in which it is nearly horizontal, or at most oblique.

PSEUDOBARIS n. g.

The species of this genus have the second joint of the funicle no longer than the third, and the club not larger, oval, with the first joint pubescent and sensitive, and constituting less than one-half the mass; the claws are approximate and slightly connate at base. In these respects they agree with *Trichobaris*, but differ by the front coxæ being very widely separated, and by the absence of dense scaly or hairy vestiture, though there are a few scattered scales on the elytra of each species. The prosternum is broadly sulcate in front; the limits of the groove are less sharply defined as in *Aulobaris*.

	Body elongate-oval, punctures of interspaces in rows	2.
	" stouter convex, confused.....................	1. **farcta.**
2.	Elytral punctures large, shallow.....................	3.
	" " small............................	4.
3.	Prothorax with sides slightly oblique................	2. **nigrina.**
	" " " nearly parallel.................	3. **angusta.**
4.	Side pieces of body densely squamose................	5.
	" " " not squamose....................	4. **pusilla.**
5.	Brown, prothorax with smooth dorsal line...........	5 **albilatus.**
	Black, prothorax without dorsal line.................	6. **T-signum.**

1. **P. farcta** (Lec.), Pr. Ac. Nat. Sc. Phil. 1868, 362, (*Baridius*).

Kansas, Colorado, and Texas. A robust convex species, having the ap-

Digitized by Google

pearance of *Centrinus*. The prosternum is broadly and tolerably deeply sulcate, thus showing a tendency towards *Aulobaris*, which it resembles in appearance, though the limits of the groove are ill-defined. The second joint of the funicle is however no longer than the third. The base of the third interspace of the elytra has a small scaly spot, and there are also scattered hair-like scales. The striæ are deep, the punctures of the interspaces are transverse and rather confused. Length 4-5 mm.; .16-.20 inch.

2. P. **nigrina** (Say), Curc. 31; ed. Lec. 1, 295, (*Baridius*); Boh., Sch. Curc. iii, 690; Boh., *ibid*, viii, 154; Lec., Pr. Ac. Nat. Sc. Phil. 1868, 363.

Southern States. The white scales are very sparse, and easily removed; they are arranged singly upon the interspaces, except at the base of the third interspace, where they form a small spot. The prosternum is broadly and deeply sulcate; the groove is sparsely punctured, and sharply limited. Length 3-4 mm.; .12-.16 inch.

3. P. **angusta** (Lec.), Pr. Ac. Nat. Sc. Phil. 1868, 363, (*Baridius*).

This species, from the material now at my command seems separable from *P. nigrina* only by its narrower form, the sides of the prothorax nearly parallel behind, and by the entire absence of smooth dorsal line of the prothorax. Specimens from Texas which are clearly referable to *P. nigrina*, vary in the last mentioned character, the dorsal line being either distinct or obsolete, so that only the form of body remains to distinguish them apart. Length 2.7-3.3 mm.; .11-.13 inch. Illinois to Kansas.

In one specimen a few scales remain, indicating a vestiture similar to the preceding. On re-examining the specimens I find my former observation that the second joint of the funicle is longer than the third is incorrect.

4. P. **pusilla** (Lec.), Pr. Ac. Nat. Sc. Phil. 1868, 363, (*Baridius*).

New York, one specimen. Allied to *P. nigrina*, but more oval and less elongate, with the punctures of the prothorax less coarse, and without smooth dorsal line; the sides are also more oblique. Head and beak sparsely finely punctured; the latter as long as the prothorax, rather slender, very slightly curved. Elytra with deep striæ, and rather wide flat interspaces, each with a row of fine but distinct punctures; the specimen is rubbed, but a few white scales are visible at the base of the third interspace, which induce me to believe that in well preserved specimens they are scattered as in the preceding species. The prosternum is broadly and strongly sulcate, and sparsely punctured, but the edges of the groove are less sharply defined than in *P. nigrina*. Length 2.5 mm.; .10 inch.

5. P. **albilatus**, n. sp.

Elongate, brown, shining; with a small elongate spot at the base of the third interspace, and the side pieces of meso- and metathorax densely clothed with white scales. Beak punctured, feebly striate near the base; head finely punctured. Prothorax a little longer than wide, rounded on the sides in front, not constricted at tip; disc coarsely, rather densely punctured, with a narrow smooth dorsal line. Elytra not wider than the pro-

Digitized by Google

thorax, striæ narrow, deep, impunctured; interspaces flat, each with a row of extremely small punctures; third interspace clothed for one-fifth the length with white scales. Beneath strongly punctured; sides of the last three ventral segments clothed with white scales. Length 2–3 mm.; .08 –.12 inch.

Enterprise, Florida; Messrs. Hubbard and Schwarz. The specimens are somewhat abraded, but in one of them I observe scattered white scales remaining on the prothorax and elytra. It is quite probable, therefore, that well preserved individuals are marked as in the next species, from which it differs chiefly by the larger size, brown color, smooth dorsal stripe on the prothorax, and fine punctures of the interspaces of the elytra.

6. P. **T-signum** (Boh.), Sch. Curc. viii, 1st, 154, (*Baridius*).

South Carolina, Zimmermann; Florida, Hubbard and Schwarz. Much smaller and still narrower than *P. nigrina*. Head finely punctulate, beak stout, strongly curved, as long as the prothorax, punctured, frontal constriction feeble. Prothorax scarcely longer than wide, subquadrate, sides not oblique, feebly rounded for three-fourths the length, then more suddenly rounded and narrowed to the tip, densely and strongly punctured, without dorsal line. Elytra wider than the prothorax, humeri oblique, distinct; striæ deep, interspaces flat, each with a row of fine but distinct punctures; a short line of white scales at the base of the third interspace, (and a small spot behind the middle, probably rubbed off in the specimen before me), metasternal side pieces and of the last ventral segments clothed with small white scales. Prosternum not so wide between the coxæ as in the other species, broadly and less deeply sulcate in front, club of the antennæ rather larger than usual. Length 2.2 mm.; .085 inch.

In well preserved specimens the surface is clothed with scattered, small white scales, which are more dense at the sides of the prothorax, at the base of the third interspace of the elytra, and the side pieces of the meso- and metathorax, and at the sides of last three ventral segments. These scales are however easily abraded.

AMPELOGLYPTER n. g.

This genus contains species which depredate on the small stems of grape vines and allied plants, producing excrescences. Two of them are readily distinguished from the preceding genera by the smooth and shining surface of the elytra, the interspaces of which are wide and not punctured; the striæ are fine, the posterior callus prominent, and the surface undulated by broad transverse impressions. In these respects they resemble *Madarus*, but differ by the shorter and stouter beak, the stouter antennæ, and the broadly excavated prosternum, which is not suddenly declivous between the coxæ. The front thighs are not toothed, and the claws are connate at base.

The form is also quite different from *Madarus*; the elytra are a little wider than the prothorax, as in *Baris*.

Digitized by Google

The front coxæ are very widely separated; the transvere suture between the coxæ is very well marked, and the prosternum is widely, but not deeply excavated; club of antennæ elongate-oval, annulated, pubescent.

Three species are known to me:

Elytral striæ not punctured;

Brown, prothorax obliquely narrowed from the base 1. **sesostris.**

Black, " suddenly " near the tip.. 2. **ater.**

Elytral striæ crenate; body elongate, brown, opaque.... 3. **crenatus**

1. **A. Sesostris** (Lec.), Pr. Ac. Nat. Sc. Phil. 1868, 364 (*Baridius*); Walsh, Am. Entomologist, ii, 105. *Madarus vitis* Riley, 1st Missouri Report, 131.

Western States, on cultivated vines. Somewhat narrower than the next, and easily known by the brown color and different form of the prothorax. Head scarcely punctulate, beak as long as the prothorax, slightly curved, feebly punctured, front constriction faint. Prothorax as long as wide, sparsely punctured, with a smooth dorsal line, sides oblique from the base for more than one-half the length, then rounded and narrowed for a short distance, and then broadly constricted at a greater distance than usual from the tip. Elytra very little wider than the prothorax, with a vague transverse impression near the base, and two others near the sides; posterior callus small, rather prominent; striæ fine, interspaces wide, flat. Beneath coarsely punctured. Length 3 mm.; .12 inch.

2. **A. ater**, n. sp.

Very black, shining; beak stouter and more curved than in the preceding. Prothorax more sparsely punctured, more rugose at the sides, which are scarcely narrowed for two-thirds their length, then very suddenly rounded, and constricted far from the tip. Elytra a little wider than the prothorax at base, sculptured and impressed as in the preceding. Length 3 mm.; .12 inch.

Southern and Western States, on *Ampelopsis quinquefolia*. Mentioned as *Madarus ampelopsis* by Walsh and Riley, loc. cit. sup., but not described.

3. **A. crenatus**, n. sp.

Elongate, dull ferruginous, opaque. Beak curved, as long as the head and prothorax, punctured; head not punctured. Prothorax subquadrate, sides parallel, rounded near the tip, and strongly constricted, base bisinuate; densely and coarsely punctured, constriction marked on the sides with a transverse row of larger punctures. Elytra a little wider than the prothorax, sides parallel, surface broadly impressed behind the base; striæ deep, very coarsely punctured, interspaces narrow, third and ninth carinate near the tip, and confluent, so as to leave a deep fovea between their junction and the posterior callosity, which is well marked. Beneath coarsely punctured, less so upon the abdomen; fifth ventral less convex and less densely punctured than in the two preceding species. Claws small, connate for half their length. Length 2.8 mm.; .11 inch.

Virginia, and Maryland; two specimens. Narrower even than *Pseudobaris angusta*.

Digitized by Google

MADARUS Sch.

In this genus the upper surface is very smooth and shining, and the surface of the elytra undulated, but the beak is longer than the prothorax and slender, almost as in *Centrinus*; the antennæ are longer and more slender, the first joint of the funicle as long as the three following; club elongate oval, annulated, entirely pubescent. The prosternum is extremely wide and gibbous between the coxæ; declivous in front, not excavated, but with two very short impressions. Front thighs armed with an obtuse tooth, claws approximate, but not connate at base.

The preceding genus makes a gradual transition from *Baris* to *Madarus*, and the arrangement of Lacordaire by which the genera just named are separated in two different subtribes is manifestly unnatural.

1. **M. undulatus** Boh., Sch. Curc. iii, 640; ***Rhynchænus und.*** Say, Journ. Ac. Nat. Sc. Phil. iii, 315; ed. Lec. ii, 177.

Massachusetts to Alabama, Texas, and Kansas. The northern specimens are entirely black; those from the South and West have the prothorax red. Although Boheman described all the thighs as toothed, I find that the middle and hind pairs are quite unarmed. The tooth of the front pair is rather large, but obtuse.

Group II. Centrini.

The only characters I can give for the recognition of this group, as distinguished from *Barides*, are: the elytra conjointly rounded at tip, or nearly so; the pygidium thus becomes entirely covered, or only partly exposed, and is nearly horizontal, or at most somewhat oblique, and never vertical. The last ventral is consequently regularly rounded at tip, never truncate or emarginate. In addition to these characters the ventral surface of the abdomen is more convex, frequently ascends obliquely, as in *Zygopini*, but in a much less degree. The tibial hooks are less developed than in *Baris* and its allies, and in many species are scarcely apparent. The beak and antennæ are generally of more slender form than in *Baris*, but these characters are not without exceptions, as will be seen below.

A. Body without erect bristles.

Tibiæ stout, with longitudinal grooves (as in *Baris*)	2.
" slender, not grooved	3.
2. Pectoral groove shallow, indefinite	PACHYBARIS.
" " deep, sharply defined	STETHOBARIS.
3. Side margin of prothorax as usual	4.
" " " well defined	MICROCHOLUS.
4. Third joint of tarsi broad, bilobed	5.
" " narrow	CALANDRINUS.
5. Claws separate	CENTRINUS.
" connate at base	ZYGOBARIS.
" single	BARILEPTON.

B. Body with stout erect bristles, intermixed with the dense covering of scales; tarsi narrow.

Bristles very long	EUCHÆTES.
" short	PLOCAMUS.

Digitized by Google

PACHYBARIS n. g.

A single glabrous species of very stout form and coarse sculpture represents this genus. It has the characters of *Onychobaris* except that the elytra are conjointly rounded behind, so as to cover the pygidium, and the fifth ventral, though very transverse is broadly rounded behind. The beak is slender, longer than the head and prothorax, moderately curved, and striato-punctate, a character not seen in any other of our species. The antennæ are stout, first joint of funicle elongate, second not longer than the third, remaining joint gradually stouter, merging into the club, which is elongate-oval, annulated and entirely pubescent. Prothorax broader than long, strongly but gradually narrowed from the base, rounded on the sides, scarcely constricted in front. Elytra very little wider than prothorax at base, humeral callus not prominent, gradually narrowed behind, conjointly rounded at tip. Prosternum rather broad between the coxæ longitudinally slightly concave in front, with two short impressions connected at their anterior end. Legs rather stout, thighs unarmed, tibiæ rather short, scarcely mucronate, marked with two fine lines and intervening ridge on outer surface; third joint of tarsi broadly dilated, last joint moderate, claws rather large, divergent.

1. **P. porosus**, n. sp.

Broadly oval, black, moderately shining. Beak slender, punctured in rows, sides striate; head punctured, frontal constriction obsolete. Prothorax strongly punctured, scutellar lobe large, emarginate. Elytra very deeply striate, striæ punctured, interspaces flat, each with a row of large approximate punctures, bearing very short whitish hairs. Beneath coarsely punctured. Length 3.7 mm.; .15 inch.

Enterprise, Florida, May 10th: Messrs. Hubbard and Schwarz.

STETHOBARIS n. g.

The single species of this genus is rather broadly oval, though less so than *Pachybaris*. The beak is as long as the head and prothorax, rather stout, curved finely, punctulate; head distinctly punctured, convex, frontal constriction strong, eyes narrowly separated beneath; antennæ stout, first joint of funicle elongate, second not longer than third, the following gradually a little broader; club large, elongate-oval, annulated, entirely pubescent. Prothorax broader than long, convex, rapidly narrowed in front and rounded on the sides, very strongly and tubularly constricted near the tip. Elytra gradually wider than the prothorax at base, then rounded on the sides, and conjointly rounded at tip, covering entirely the pygidium. Front coxæ rather widely separated, prosternum with a deep smooth sharply defined groove. Legs longer, rather stout, thighs not toothed, tibiæ faintly grooved, feebly armed at tip; third joint of tarsi broadly dilated, last joint small; claws very small, approximate but not connate.

Digitized by Google

1. **S. tubulatus.** *Campylorhynchus tub.* Say, Curc. 20; ed. Lec. i, 285; *Baridius ovatus* Lec., Pr. Ac. Nat. Sc., Phil., 1868, 363.

Middle, Southern and Western States. The prothorax is deeply but not very densely punctured, and the scutellar lobe is prominent, and subemarginate; the dorsal line is faint, or wanting. The elytra are deeply striate, the striæ are punctured, and the interspaces are narrow, each with a row of fine but distinct punctures, bearing very short white hairs; beneath coarsely punctured, last ventral segment densely punctured. Length 2.5–3 mm.; .10–.12 inch.

There may be some doubt about the reference of Say's name to this species in consequence of the expression, "interstitial lines flattened, and with a series of punctures each furnishing a recurved, whitish hair," which would seem referable rather to the genus *Zaglyptus* (p. 236) of the *Ithyporus* group of *Cryptorhynchini*. In other respects the description so well accords with the present insect, that I prefer suppressing the name proposed by me as a synonym, until some other insect occurs better suited to Say's description. In case this should happen the name *ovatus* can be restored.

MICROCHOLUS n. g.

Form of body like *Baris*, but stouter and more convex, with a few scattered white scales. Beak as long as the prothorax, curved, cylindrical, rather stouter towards the base, not striate, scarcely perceptibly transversely impressed at base: head broad, convex, eyes widely separated, flat, finely granulated, pointed beneath; antennal grooves commencing nearly one-third from the tip, narrow, running obliquely downwards, almost confluent. Antennæ with seven-jointed funicle, first joint as long as the three following united, slender, slightly clavate in *M. striatus* and *M. puncticollis*, shorter and stouter in *M. lævicollis*; second a little longer than third; 3–7 gradually slightly broader; club elongate-oval, pubescent, annulated towards the tip. Prothorax strongly narrowed in front, constricted at tip, sides rounded, flanks concave, so as to cause the lateral edge, though not acute, to appear well defined; base truncate; post-ocular lobes wanting: prosternum short, slightly concave, rather narrow between the coxæ; middle coxæ moderately widely, hind coxæ more widely separated, the latter not reaching the side of the body. Scutellum very small. Elytra truncate at base, humeral angles rounded, a little narrower than the prothorax, sides rounded and obliquely narrowed behind; pygidium entirely covered by the conjointly rounded tips; disc very convex, striæ sometimes indistinct. Mesosternum short, ventral segments slightly unequal, sutures scarcely curved. Thighs rather long and stout; tibiæ rather short, sinuate, feebly mucronate; tarsi with third joint very broadly dilated and bilobed; last joint slender, with very small claws.

Prothorax punctured, constriction near the tip........ 1. **striatus.**
Elytra with well-marked striæ........................ 2. **puncticollis.**
Prothorax smooth, constriction distant from the tip.... 3. **lævicollis.**

Digitized by Google

1. **M. striatus**, n. sp.

Robust, convex, black, thinly clothed with oval white scales, more densely placed on the under surface, but easily removed by abrasion, and of which but few remain in the specimen. Beak nearly smooth, feebly impressed transversely at base. Prothorax wider than long, sides oblique, rounded, very much narrowed in front, moderately constricted near the tip, sparsely finely punctured, punctures less distinct towards the sides, which are more obtuse than in the other two species. Elytra not narrower than the prothorax, gradually less narrowed behind than in the other two species; striæ well marked, rather deep, interspaces broad, flat, each with a row of feeble punctures. Antennæ with the first joint of funicle slender, much longer than the second. Beneath rather coarsely punctured, but not very deeply so on the flanks of the prothorax. Length 4.3 mm.; .17 inch.

One specimen, Lake Harney, Florida, May 4th; Messrs. Hubbard and Schwarz. Probably a female, in which case the male would have the prothorax wider and more rounded on the sides, and the lateral edge more compressed.

2. **M. puncticollis**, n. sp.

Robust, very convex, black, uniformly, but thinly clothed with silvery white oval scales, more densely placed on the under surface. Head glabrous behind the eyes, punctured in front, nearly smooth behind; beak punctured, scaly, not impressed at base; front scaly. Prothorax wider than long, strongly rounded on the sides, hind angles rounded, lateral edge nearly acutely defined; strongly narrowed in front, and rather strongly constricted near the apex, which is scarcely one-half as wide as the base; disc strongly punctured, more densely towards the sides, with a broad, smooth dorsal space. Elytra narrower than the prothorax, broadly but obliquely narrowed on the sides; striæ fine, in some places indistinct, interspaces broad, sparsely irregularly punctulate. Antennæ with the first joint of funicle twice as long as the second, which is longer than the third. Beneath rather coarsely punctured; punctures of the flanks of the prothorax equally deep. Length 3.7 mm.; .15 inch.

Baldwin, Florida, June 10; many specimens; Messrs. Hubbard and Schwarz.

3. **M. lævicollis**, n. sp.

Robust ovate, very convex, almost gibbous, black, shining (sparsely squamose, with linear white scales, which have been mostly removed by abrasion). Beak sparsely punctured, feebly transversely impressed at base; head convex, sparsely punctulate in front, smooth behind. Prothorax twice as wide as long, very convex, strongly narrowed in front, sides obliquely narrowed, very strongly constricted about one-fourth from the apex, which is half the width of the base; the latter is not truncate, but very broadly rounded; surface feebly and sparsely punctulate, lateral edge nearly acutely defined. Elytra not narrower than the prothorax at base,

Digitized by Google

basal angles not rounded, sides gradually narrowed and slightly rounded to the tip; striæ fine, feebly punctured, ending near the base in deep foveæ; interspaces broad, flat, smooth. Antennæ with the first joint of funicle scarcely longer than the second, but somewhat stouter than in the other two species. Length 2.2 mm.; .09 inch.

St. Louis, Missouri; one specimen; Mr. M. Schuster. The prothorax is more rapidly narrowed in front and more strongly tubulate than in any other Curculionide known to me in our fauna.

CALANDRINUS, n. g.

The small insect which constitutes this genus bears a singular resemblance in miniature to *Sphenophorus*, but is clothed with scale-like hairs, as in *Centrinus*.

Beak slender, cylindrical, curved, as long as the head and prothorax, separated from the head by a transverse constriction; head rather large, convex; eyes distant, flat, pointed beneath, finely granulated; antennal grooves descending obliquely towards the lower angle of the eyes. Antennæ with the scape not attaining the eyes; funicle 7-jointed, first joint as long as the second and third united, but scarcely stouter; second longer than third; 3–7 gradually wider, merging into the club, which is elongate-oval, pointed, pubescent and annulated. Prothorax two-thirds as long as the elytra, longer than wide, rounded on the sides, a little wider near the middle, narrowed before the middle, constricted, but not tubulate towards the apex; base broadly bisinuate, basal angles slightly obtuse, scutellar angle very broad; postocular lobes wanting; prosternum long in front of the coxæ, which are rather widely separated; scutellum very small, punctiform. Elytra elongate-oval, a little wider than the prothorax, sides rounded, forming an obtuse angle with the sides of the prothorax; striæ deep, not punctured; tips conjointly rounded, covering entirely the pygidium. Middle and hind coxæ widely separated; metasternum short, ventral segments unequal, sutures angulated at the sides; fifth segment as long as the two preceding united. Thighs moderately long; tibiæ strongly unguiculate at tip; tarsi narrow, third joint scarcely wider than second, not bilobed, last joint as long as the others united, claws simple, divergent, rather large.

It is singular to find in this genus a recurrence of the narrow tarsi already so frequently noticed in other tribes, without any important structural modification, but with an outline of body suggestive of a very different type.

1. **C. grandicollis**, n. sp.

Piceous, clothed with hair-like and narrow pale scales; beak, antennæ and legs brown. Beak not punctured, head sparsely punctured, with a larger frontal puncture. Prothorax coarsely punctured, with an elongate, smooth dorsal spot, attaining neither base nor tip; apical margin also smooth. Elytra with deep impunctured striæ, interspaces flat, each with a row of deep punctures; third interspace wider, with the punctures confused. Beneath coarsely punctured. Length 3 mm.; .12 inch.

Digitized by Google

One specimen, collected by me near the Rocky Mountains. The scales are partly abraded; on the elytra they remain only at the base and near the extremity of the fourth to the seventh interspaces.

CENTRINUS Sch.

After separating a certain number of species, which seem to indicate distinct and well-defined genera, there remains a tolerably numerous mass, which, although not entirely homogeneous, consists of species having in common the following characters. The study of foreign species may permit at a future time a farther subdivision, but the transition between the extreme forms seems so gradual, that I am unwilling, with my present knowledge, to indicate the manner in which this may be effected.

The beak is long and slender, cylindrical, and usually curved, but sometimes nearly straight; the antennal grooves commence about the middle, descend obliquely, and are wider, deeper and confluent behind. Mandibles small, flattened, pointed, prominent, and without teeth. Antennæ rather slender, funicle 7-jointed, joints 1–3 varying in length, 4–7 equal in length, not passing into the club, which is oval, somewhat pointed, pubescent and annulated. Prothorax narrowed and more or less constricted in front, without postocular lobes; prosternum long in front of the coxæ, which are rather widely separated; not emarginate in front, impressed or not, according to species. Elytra sometimes elongate with parallel sides, though usually narrowed from the humeri, so as to give a rhomboidal form of body; posterior callosity feeble, tips usually conjointly rounded, sometimes separately rounded, exposing in the latter case a small part of the pygidium, which is, however, horizontal, and not vertical, as in *Baris* and its allies. The middle and hind coxæ are widely separated; metasternum rather short, with wide episterna in the rhomboidal species; longer, with narrower episterna in the elongate species; but in both cases distinctly wider before and behind. Ventral surface ascending in some species, nearly horizontal in others; first and second joints longer than third and fourth; fifth sometimes longer, sometimes not longer than the fourth: first suture subsinuate, the others strongly angulated at the sides. Thighs unarmed, tibiæ not striate on the outer side, very feebly mucronate at tip; tarsi with the third joint very broad, bilobed, last joint long, with stout, divergent claws.

In the males of several species the prosternum just in front of the coxæ is armed with a slender process, which varies in length according to the individual, but not according to species.

A. Elytra separately strongly rounded at tip; pygidium partly exposed: posterior edge of prothorax deeply emarginate beneath in front of mesosternum.

Black, densely punctured; above pruinose, with fine scales or hairs, beneath scaly: scutellum clothed with white scales ..... 1. **scutellum-album.**

B. Elytra conjointly rounded at tip, or nearly so; pygidium not exposed, or very slightly visible; posterior edge of prothorax usually emarginate in front of mesosternum;* form subrhomboidal, side pieces of metathorax wide.

Emargination of hind margin of prothorax small ... 2.
Emargination of hind margin of prothorax deep; body densely clothed with coarse capillary scales; elytra sometimes with denuded spots... 2. **penicellus.**
2. Prothorax tubularly constricted in front.......... 3.
" moderately " " " .... 5.
Beak strongly punctured and striate; prothorax coarsely punctured.......................... 4.
3. Beak nearly smooth; prothorax more finely punctured...................................... 3. **laevirostris.**
Beak strongly punctured; prothorax less finely punctured .... 4. **punctirostris.**
4. Sides of prothorax strongly rounded; prosternum deeply impressed in front of the coxæ, emarginate behind.................................. 5. **striatirostris.**
Sides of prothorax oblique, feebly rounded; prosternum impressed near the apex, not emarginate behind................................ 6. **modestus.**
5. Sides of prothorax much rounded................ 6.
" " oblique, feebly rounded........ 7.
6. Pubescence gray squamose .... 7. **perscillus.**
" " capillary, (prosternum not emarginate behind)............................. 9. **capillatus.**
7. Prothorax gradually narrowed in front.......... 8.
" more suddenly narrowed near the tip.. 8. **neglectus.**
8. Second joint of funicle equal to third; scales uniform .... 9.
Second joint of funicle longer than third; scales yellow and black, forming stripes............ 12. **lineellus.**
9. Prosternum with three impressions in front...... 10. **picumnus.**
Prosternum with one small impression near the apical margin............................. 11. **perscitus.**

C. Elytra conjointly rounded at tip, or nearly so; pygidium not exposed or very slightly visible; posterior edge of prosternum not emarginate in front of mesosternum; form elongate.

Prosternum transversely impressed as usual by the subapical constriction....................... 2.
Prosternum with two slight ridges, indicating a broad but feeble pectoral groove.............. 8.
Prosternum foveate near the apical margin.......... 9.
2. Scales moderately large, quite evident........... 3.
" small, hair-like, inconspicuous .. .. 5.

* The exceptions are *C. modestus*, *capillatus*, and perhaps *lineellus*.

Digitized by Google

3. Front coxæ not widely separated............. ...	4.
" " widely separated, form more robust ..	13. griseus.
4. Interspaces of elytra with double or confused rows of scales....................................	14. decipiens.
Interspaces of elytra with single rows of scales......	15. lineicollis.
5. Interspaces of elytra with single rows of punctures	6.
" " " confused " "	7.
6. Rows of punctures very strong.............	16. punctiger.
" " fine........................ ...	17. nasutus.
7. Prothorax suddenly constricted in front, beak curved....................................	18. calvus.
Prothorax less constricted in front, beak nearly straight	19. rectirostris.
8. Prothorax very densely punctured................	20. falsus.
" less " "	21. longulus.
9. Prosternal impression single......................	10.
" " double.....................	22. concinnus.
10. Elytral striæ deep; interspaces strongly punctured	23. confusus.
" " fine; " feebly "	11.
11. Prosternal impression quadrate..................	24. prolixus.
" " small, round.....	25. confinis.

1. **C. scutellum-album** Say, Curc. 21; ed. Lec. i, 287; *Baridius scut.* Germ. Sch. Curc. iii, 730.

An abundant species over the whole of the Atlantic district. Varies considerably in size (3–4.7 mm.; .12–.18 inch). the smallest specimens occurring in all parts of the country; also in form, some of the smaller specimens from Texas being less robust, with the sides of the prothorax less rounded; also in vestiture, which is sometimes denser and yellowish, and squamose upon the elytra, in specimens from Texas. The white scales of the scutellum are not unfrequently removed by abrasion. The antennæ are stouter than in the following species, and the second joint of the funicle of the antennæ is distinctly longer than the third; the prosternum is deeply transversely impressed, and is flattened behind the impression, but has no trace of spines in either sex. The metasternal episterna are wide; the fifth ventral is scarcely longer than the fourth. The anal segment is exposed in the ♂, and is slightly declivous. Of all the species in our fauna, this makes the nearest approach to *Baris.*

2. **C. penicellus.** *Curculio penicellus* Herbst, Käfer, vii, 29, Tab. 99, f. 6; *Baridius pen.* Say, Curc. 17; ed. Lec. i, 281; *Centrinus holosericeus* Gyll., Sch. Curc. iii, 760; *Baridius pubescens* Uhler, Proc. Acad. Nat. Sc. Phila. vii, 417.

New York to Florida and Louisiana. The vestiture is of narrow-pointed brassy yellow scales, or coarse flattened hairs. on the prothorax they point transversely towards the middle, which is slightly carinate; on the elytra they form three nearly regular rows, upon each of the densely punctured

Digitized by Google

interspaces. In some specimens the elytra are uniformly clothed, without any denuded spots. The second joint of the funicle is as long as the first, but more slender. The elytra are conjointly rounded at tip, and the pygidium is not visible. The prosternum is transversely impressed and flattened, as in the preceding species, not armed in the ♂; the emargination in front of the mesosternum is wide and deep, limited by sharp angles. The metathoracic episterna are wide, and the fifth ventral but little longer than the fourth.

C. pistor Gyll., Sch. Curc. iii, 760; *Balaninus pistor* Germ., Ins. Nov. 295, and

C.(?) dilectus Harris, Trans. Hartf. Nat. Hist. Soc. i. 80,

Are unknown to me. I think it possible that the latter may be a large variety of *penicellus*; the former is perhaps the ♀ of the next.

3. **C. lævirostris**, n. sp.

Black, densely clothed with small gray scales, which are narrower but not hair-like upon the upper surface. Beak as long as the head and prothorax, slender, curved, opaque, smooth, slightly punctured and pubescent near the base; head feebly punctulate. Prothorax not wider than long, rapidly narrowed from the base, strongly rounded on the sides, very strongly tubularly constricted near the tip, bisinuate at base; scutellar lobe slightly emarginate; surface densely rather finely punctured, scales not directed transversely; dorsal line smooth, slightly elevated. Elytra conjointly rounded at tip, pygidium slightly visible (only in ♂?); striæ deep but not broad, interspaces flat, densely punctured; suture and alternate spaces clothed with paler scales. Antennæ with the second joint of funicle two-thirds as long as the first. Side pieces of metasternum wide; fifth ventral nearly as long as third and fourth united. Hind margin of prothorax beneath narrowly emarginate. Length 6.2 mm.; .25 inch.

♂. Prosternum with a very deep excavation in front of the coxæ, and armed each side of the cavity with a long curved horn: ♀ wanting.

Missouri, one specimen. This is the largest species in our fauna, and corresponds in size with *C. pistor* and *dilectus*; I do not feel disposed however, to refer it to either of them.

4. **C. punctirostris**, n. sp.

This species corresponds in all respects with *C. lævirostris*, except that the scales are of a uniform pale gray; the beak is stouter, especially at the base, coarsely punctured even at the tip, with a small smooth space at the base. and the punctures of the prothorax though dense, are somewhat larger. Length 6.2 mm ; .25 inch.

Colorado, one ♂. The horns of the prosternum are shorter, and more regularly curved.

5. **C. striatirostris**, n. sp.

More robust than the two preceding species. Beak not very slender, more curved near the base; shining, coarsely punctured, longitudinally

Digitized by Google

rugose on the sides, strongly constricted at the base. Prothorax wider than long, much rounded on the sides, strongly tubularly constricted at tip; very coarsely and somewhat confluently punctured; scales sparse, white, narrow, directed transversely; dorsal line narrow; scutellar lobe broad, slightly emarginate. Elytra not wider than the prothorax, gradually narrowed behind the humeri, thinly clothed with white scales broader than those of the prothorax, tips separately but narrowly rounded; striæ deep, broad and punctured; interspaces narrow, with large punctures nearly arranged in single rows. Funicle of antennæ with the second joint half as long as the first. Beneath coarsely punctured, clothed not very densely with oval white scales. Hind margin of prothorax emarginate beneath; side pieces of metasternum wide; fifth ventral shorter than third and fourth united. Length 4.6 mm.; .18 inch.

Texas, Belfrage, one ♂. The prosternum is deeply excavated as in the two preceding species, but the horns are much shorter, and scarcely curved. This, however, may be an individual character.

6. C. **modestus** Boh., Sch. Curc. iii, 772.

Middle and Southern States. Similar in form to the preceding species, black, sprinkled with small oval white scales. Beak as long as the head and prothorax, stout, regularly curved, sparsely punctured. Prothorax wider than long, feebly rounded on the sides, which are oblique, strongly constricted at tip; densely, somewhat confluently punctured, with a narrow smooth dorsal line. Elytra conjointly rounded at tip; striæ deep, interspaces coarsely punctured. Prosternum with a well defined deep impression, rounded in front, extending nearly to the anterior margin; coxæ moderately widely separated, hind margin not emarginate; side pieces of metathorax wide; fifth ventral segment a little longer than fourth. Funicle of antennæ with first joint elongate, second a little longer than third. Length .4 mm.: .15 inch.

♂ with a small cusp each side, immediately before the front coxæ; abdomen flattened near the base; anal segment slightly visible on the under surface.

7. C. **perscillus** Gyll., Sch. Curc. iii, 762.

Kansas, one male. The scales are dirty gray, not linear but oval, and densely placed. The prothorax is wider than long, rapidly narrowed from the base, with the sides not very much rounded, and the tip only feebly constricted. The elytra are conjointly rounded at tip, and the pygidium is not exposed; the striæ are deep and punctured. The second joint of the funicle is as long as the first, the side pieces of the metasternum are wide, the fifth ventral is but little longer than the fourth, and the hind margin of the prothorax beneath is narrowly emarginate in front of the mesosternum. Length 3.5 mm.; .14 inch.

The prosternum is deeply excavated, and the horns are short and conical.

8. C. **neglectus**, n. sp.

Very similar to *C. perscillus*, but rather narrower, clothed with ochreous

Digitized by Google

narrow scales. Prothorax scarcely wider than long, sides obliquely rounded, feebly constricted at tip; disc densely punctured; scales hair-like, directed transversely, dorsal line obsolete. Elytra scarcely wider than the prothorax, gradually narrowed from the humeri, tips conjointly rounded; striæ deep and wide, interspaces flat, densely punctured. Beneath covered with oval scales; antennæ and legs brown; prosternum as wide between the coxæ as in *C. perscillus*, emarginate in front of the mesosternum; side pieces of metasternum wide; fifth ventral scarcely longer than the fourth. Beak long, slender, curved, shining and sparsely pubescent, distinctly punctured; second joint of funicle nearly as long as the first. Length 2.5 mm.; .10 inch.

Louisiana and Kansas, four specimens. The prosternum is broadly but less deeply impressed; in the ♂ the horns are very short; in the ♀ the prosternum is flattened, but not concave.

9. **C. capillatus**, n. sp.

Similar in size and form to *C. perscillus*, but only thinly clothed with hair-like white scales on the upper surface, intermixed with oval scales on the under surface. Beak as long as the head and prothorax, slender, abruptly curved near the base, then nearly straight, shining, smooth, sparsely punctured near the base, frontal constriction very feeble; head convex, sparsely punctured. Prothorax wider than long, sides oblique, very slightly rounded, tip feebly constricted; disc densely punctured, scales directed transversely; base bisinuate, scutellar lobe rather large, truncate. Elytra somewhat wider than the prothorax, narrowed behind from the humeri, separately (though very slightly so) rounded at the tips; pygidium not exposed; striæ deep and broad, interspaces flat, densely punctured, each with two rather regular rows of hair-like scales. Prosternum not very wide between the coxæ, hind margin truncate in front of the mesosternum, not at all emarginate; side pieces of metathorax wide; fifth ventral longer than the fourth; antennæ with the first joint of the funicle long and slender, second two-thirds as long, equal to the third and fourth united. Length 3 mm.; .12 inch.

♂. Prosternum broadly and feebly concave; horns reduced to a small slender cusp; ventral surface flattened, fifth segment as long as the third and fourth united.

♀. Prosternum slightly convex, without horns; ventral surface convex, fifth segment a little longer than the fourth.

Texas, Belfrage, three specimens.

10. **C. picumnus**. *Curculio pic.* Herbst, Käfer, vii, 30; Tab. 99, f. 9; *Baridius pic.* Say, Curc. 17; ed. Lec. i, 281; *Centrinus olivaceus* Gyll., Sch. Curc. iii, 763; *Centrinus sutor* Harris, Trans. Hartford Nat. Hist. Soc. i, 81.

Abundant throughout the Atlantic region. Rather broader, and more regularly oval, densely clothed with narrow, ochreous scales, which are broader and paler on the under surface. Beak long, slender, regularly and

Digitized by Google

strongly curved, frontal constriction deep. Prothorax wider than long, narrowed from the base, sides oblique, scarcely rounded, feebly constricted near the tip; surface densely punctured, scales directed transversely; scutellar lobe long. Elytra scarcely wider than the prothorax, gradually narrowed from the humeri, tips separately very slightly rounded, pygidium exposed at tip; striæ deep, punctured, interspaces flat, densely punctured, scales in about three nearly regular series on each interspace. Beneath densely punctured; prosternum transversely impressed, slightly concave near the tip and also each side; moderately wide between the coxæ; sharply emarginate in front of the mesosternum; metathoraic side pieces wide; fifth ventral segment scarcely longer than fourth. Funicle of antennæ with the first joint as long as the three following united; second not longer than third. Length 2.5 mm.; .10 inch.

♂. Prosternum with a long, nearly straight horn in front of each coxa; varies with the horns very short. Beak punctured and striate.

♀. Prosternum without horns. Beak sometimes punctured and striate, as in the ♂; sometimes feebly punctured and not striate.

11. **C. perscitus** Sch. Curc. iii, 764; *Curculio pers.* Herbst, Käfer, vii, 28; Tab. 99, f. 3.

Georgia and Texas; two specimens. Similar in size and form to the preceding, but the scales are more hair-like, and are more densely placed on the sides of the prothorax. The striæ of the elytra are finer, and the interspaces consequently wider. The front coxæ are moderately distant, and the prosternum is concave at the middle, but not impressed at the sides; the hind margin is very slightly rounded, not emarginate; the metathoracic side pieces are wide, and the fifth ventral is scarcely longer than the fourth. Funicle of antennæ rather stout, first joint as long as the three following; second scarcely longer than the third. Prosternum without horns in the ♂. Length 2.5 mm.; .10 inch.

12. **C. lineellus** Lec. Proc. Ac. Nat. Sc. Phil. 1859, 79.

Tejon, California; one female; Mr. Xántus. Enterely similar in form and size to the two preceding, but the scales are oval, and of two colors, sulphur-yellow and black; the first color, though paler, prevailing on the under surface; and forming also three broad vittæ on the prothorax. Scutellum black. Elytra with the whole of the second interspace; the third, except for the basal fourth; the fourth for the basal fifth; the sixth for the anterior half; the seventh and eighth for the posterior two-thirds covered with yellow scales, arranged in two or three rows on each interspace; striæ rather deep, punctured. Prosternum convex, transversely impressed, as usual, but not concave; front coxæ widely separated. Metathoracic side-pieces wide; abdomen convex; fifth ventral not longer than fourth. Funicle of antennæ rather slender; second joint a little longer than the third, Length 2.5 mm.; .10 inch.

13. **C. griseus**, n. sp.

Less elongate than the following species, proportioned somewhat as

Digitized by Google

C. capillatus, but with the prothorax more rounded on the sides, and more constricted in front. Beak shorter than the prothorax, not very slender, regularly curved, punctured and striate; transverse frontal impression distinct; head convex, opaque, finely punctulate. Prothorax wider than long, sides parallel behind, much rounded in front, strongly constricted near the tip; disc coarsely and densely punctured, clothed with narrow, pale scales, directed transversely. Elytra feebly narrowed from the humeri, separately rounded at the tip; pygidium slightly exposed; striæ deep, interspaces rather narrow, punctured; each clothed with an irregular double series of narrow, white scales. Prosternum with the usual transverse impression, not foveate, hind margin not emarginate; front coxæ widely separated; metathoracic side pieces wide; fifth ventral segment nearly as long as the third and fourth united; antennæ with rather stout funicle, second joint scarcely longer than the third. Length 3.7 mm.; .15 inch.

Texas, Belfrage; one specimen. This is a deceptive and difficult species to identify, and would be equally well placed near *C. modestus* and *capillatus*.

14. **C. decipiens**, n. sp.

More elongate than the preceding, but otherwise closely resembling it. The beak is similarly curved and sculptured, but is longer. The prothorax is not constricted in front, and the scales are somewhat less narrow, though also directed transversely; the sides are much less rounded. The elytra are deeply striate, clothed with narrow, pale scales, arranged in rather confused single series on the inner interspaces, but with regular rows on the outer ones. The body beneath is densely clothed with oval pale scales; the prosternum is transversely impressed as usual, but also slightly foveate and flattened, though the fovea is concealed by the scales. The front coxæ are not widely separated, the metathoracic side pieces are wide. and the fifth ventral segment is nearly as long as the third and fourth united. Funicle of antennæ rather slender; second joint a little longer than third. Length 3 mm.; .12 inch.

Florida and Texas; two specimens.

15. **C. lineicollis** Boh., Sch. Curc. viii, 1st, 221.

Illinois, Texas, South Carolina, also occurs in Mexico. An elongate species, thinly clothed with small, narrow, gray scales, which are almost hair-like on the upper suface; and rather dense at the middle and sides of the prothorax; on the elytra they are arranged in single series on each interspace.

The beak is as long as the prothorax, curved, sparsely punctured, and striate at the sides. Prothorax densely punctured, longer than wide, feebly constricted near the tip. Elytra conjointly rounded at tip, striæ deep, interspaces rugosely punctured. Prosternum transversely impressed in front, not emarginate behind; front coxæ only narrowly separated; metathoracic side-pieces rather narrow; fifth ventral nearly as long as third and fourth united. Funicle of antennæ rather stout; first joint as long as the two following; second a little longer than the third. Length 2.5 mm.; .10 inch.

Digitized by Google

16. **C. punctiger**, n. sp.

Elongate oval, narrowed before and behind, dull black, nearly glabrous above. Beak brown, as long as the prothorax, slender, curved, punctured towards the base, frontal impression distinct. Prothorax as wide as long, much narrowed in front, broadly but not abruptly constricted, sides rounded; disc coarsely and deeply punctured, dorsal line narrow. Elytra with deep punctured striæ, interspaces each with a row of deep punctures; tips nearly conjointly rounded. Beneath coarsely and densely punctured, scarcely pubescent; prosternum convex, very deeply constricted in front, not emarginate behind; front coxæ widely separated; metathoracic side pieces rather narrow; fifth ventral nearly as long as third and fourth united. Legs and antennæ brown, funicle rather slender; second joint scarcely longer than third; club rather shining for half its length, annulated only towards the tip. Length 3 mm.; .12 inch

Texas, Belfrage; one specimen. By the structure of the antennal club this species approaches *Baris*, but the beak and antennæ are slender, and the ventral segments are those of the present genus.

17. **C. nasutus**. *Baridius nasutus* Lec., Pr. Acad. Nat. Sc. 1859, 79.

Tejon, California; two specimens. Beak slender, curved, punctured and striate; prothorax longer than wide, broadly rounded on the sides, narrowed in front of the middle, feebly constricted near the tip; rather closely punctured, shining, sparsely pubescent. Elytra with deep punctured striæ, interspaces with single rows of small punctures and very fine hairs; tips conjointly rounded. Beneath not coarsely but rather densely punctured. Prosternum transversely impressed as usual, not emarginate behind; front coxæ widely separated; metathoracic side-pieces rather narrow; ventral segments less punctured, with a small cusp at the middle of the hind margin of the first, where the suture is effaced; fifth segment as long as the third and fourth, more densely punctured. Antennæ with the second joint of funicle a little longer than third. Length 4 mm.; .16 inch.

I refer to this species a much smaller specimen (2.5 mm.; .10 inch) from Texas.

18. **C. calvus**, n. sp.

Elongate oblong, dull black, thinly clothed with fine, short hairs, which, on the under surface, become scale-like. Beak as long as the prothorax, not slender, slightly curved about the middle, nearly straight at base and tip, strongly striate and punctured; front not transversely impressed; head feebly punctulate. Prothorax scarcely wider than long, sides nearly straight and parallel for more than half the length, then suddenly rounded and tubularly constricted; surface densely, not coarsely punctured, with indistinct dorsal line; base nearly straight. Elytra but little wider than the prothorax, sides parallel behind the humerl, then broadly rounded; tips separately rounded, exposing a small part of the pygidium, which is slightly declivous, but by no means vertical; striæ deep, scarcely punctured, interspaces wide, confusedly and rugosely punctured. Beneath, rather

Digitized by Google

densely, not coarsely punctured; prosternum rather flat, less deeply impressed in front than usual, very slightly emarginate behind; hind margin not emarginate; front coxæ moderately widely separate; metathoracic side pieces rather narrow; fifth ventral segment as long as the two preceding; second joint of funicle longer than the third. Length 4.5–5.2 mm.; .18–.21 inch.

♂. First ventral segment flattened and slightly concave at the middle; prosternum without spines.

♀. Ventral surface convex, not impressed; form a little stouter; beak more slender, less deeply sculptured.

Georgia and Florida; two specimens. The description is drawn from the ♂, which is the larger specimen.

19. C. **rectirostris**, n. sp.

More elongate, black, nearly glabrous, shining. Beak longer than the head and prothorax, nearly straight, slender, sparsely punctured, with a small basal indentation; head convex, feebly punctulate. Prothorax scarcely longer than wide, slightly narrowed from the base forwards, then more narrowed and rounded, broadly constricted near the tip; surface strongly punctured, dorsal line narrow, distinct. Elytra a little wider than the prothorax, sides parallel behind the humeri, then rounded; tips separately rounded, exposing a small part of the pygidium; striæ deep, narrow, interspaces wide, finely rugosely punctured. Beneath slightly pubescent, not coarsely punctured; more sparsely on the first and second ventral segments. Prosternum transversely impressed in front, not emarginate behind; front coxæ moderately widely distant; metathoracic side-pieces not very narrow; fifth ventral segment as long as the two preceding united. Funicle of antennæ slender, second joint nearly as long as the first. Length 4.8 mm.; .19 inch.

South Carolina and Illinois; three specimens. I have adopted the name given to it by Dr. Zimmermann. The beak of the ♂ is more strongly punctured and striate, and a little shorter.

20. C. **falsus**, n. sp.

Elongate oval, dull black, clothed not very densely with narrow yellowish scales, which are broader and paler on the under surface. Beak as long as the head and prothorax, more curved at the base, not very slender, strongly punctured (♂); sparsely punctured (♀); head punctured, front with a small fovea, not transversely impressed. Prothorax wider than long, slightly narrowed from the base, rounded and feebly constricted towards the tip; densely and strongly punctured; dorsal line narrow, distinctly elevated; hairs transversely arranged, base nearly straight. Elytra slightly separately rounded at tip, apex of pygidium exposed; striæ deep, interspaces wide, densely and confusedly punctured, hairs not arranged in rows. Beneath densely punctured, prosternum transversely impressed as usual, and longitudinally concave; apical part foveate, and with a small ridge each side of the fovea; hind margin not emarginate; front coxæ mod-

Digitized by Google

erately distant, metathoracic side pieces rather wide, fifth ventral segment hardly longer than the fourth. Funicle of antennæ slender, first joint as long as the three following; second a little longer than the third; club less elongate, stouter, pubescent, less distinctly annulated. Length 4 mm.; .16 inch.

Middle and Southern States; four specimens.

21. **C. longulus**, n. sp.

This species closely resembles *C. falsus*, but is still more elongate and clothed with hair-like scales both above and beneath. The prothorax is not wider than long, and is less constricted at the tip; the punctures are less dense, and the dorsal line is indistinct. The prosternum is more distinctly sulcate, and the fifth ventral segment is distinctly longer than the fourth. Length 4 mm.; .16 inch.

Texas. Belfrage; one ♂. The beak is nearly smooth, punctured only towards the base. The first ventral segment is slightly flattened.

22. **C. concinnus**, n. sp.

Elongate, black, with a slight bronzed tint, thinly clothed with white hairs, becoming capillary scales beneath. Beak as long as the prothorax, slightly curved, frontal impression distinct. Prothorax a little longer than wide, narrowed and feebly constricted in front, coarsely but not deeply punctured, finely alutaceous. Elytra parallel, conjointly rounded at tip; striæ fine, interspaces wide, feebly punctulate. Beneath rather coarsely punctured; prosternum with two small foveæ near the tip; not emarginate behind; front coxæ moderately distant; metathoracic side pieces narrow, fifth ventral segment longer than the fourth. Funicle of antennæ rather stout and short, second joint not longer than third. Length 1.8–2.5 mm.; .07–.10 inch.

New York, Florida, Texas. The beak is striate and more deeply punctured in the ♂.

23. **C. confusus** Boh., Sch. Curc. iii, 740; Mann., Bull. Mosc. 1843, 2d, 293.

Southern and Western States; also found in California, according to Mannerheim. Elongate, dull black, thinly clothed with white hairs, which are very small and inconspicuous above, and scale-like beneath. Beak as long as the prothorax, slender, slightly curved. Prothorax strongly and densely punctured; dorsal line narrow, smooth; sides slightly oblique, rounded in front, and feebly constricted. Elytra with deep striæ, interspaces strongly punctulate, tips conjointly rounded. Beneath coarsely punctured, prosternum with a rounded impression near the tip; not emarginate behind; front coxæ moderately separated, metathoracic side pieces rather narrow; fifth ventral segment a little longer than the fourth. Funicle of antennæ stout, second joint scarcely longer than third. Length 2.8 mm.; .11 inch.

♂. Prosternum armed each side in front of the coxæ with a long straight

Digitized by Google

horn; beak more distinctly punctured and striate. Varies with the horns short.

♀. Prosternum flattened, but without horns; beak smoother, punctured towards the base.

Two larger specimens from Florida have the prothorax less densely punctured, and the fifth ventral as long as the third and fourth united; in the ♂ the horns are merely short acute cusps. They may indicate a distinct species, but I prefer not to define it as such for the present.

24. C. **prolixus**, n. sp.

Elongate, shining black, with a slight bronzed lustre, nearly glabrous above. Beak slender, slightly curved, as long as the prothorax; frontal impression wanting. Prothorax as wide as long, narrowed in front and rounded upon the sides, broadly but not deeply constricted in front; disc less convex than usual, sparsely punctured. Elytra very elongate, parallel, conjointly rounded at tip; striæ fine, interspaces wide, with small distant fine punctures; disc vaguely impressed behind the base. Beneath slightly pubescent, not deeply punctured, prosternum broadly concave, with a small square impression near the tip; front coxæ not widely separated; metathoracic side pieces narrow; ventral segments very sparsely punctured; fifth as long as the third and fourth united. Funicle of antennæ rather slender, second joint hardly longer than third. Length 4 mm.; .15 inch.

Massachusetts and Illinois; three specimens. Somewhat resembles *C. rectirostris*, but is smaller, and quite different by the characters given above.

25. C. **confinis**, n. sp.

This species exactly resembles *C. concinnus* in size, form and sculpture, but differs by the finer pubescence, which is almost inconspicuous on the upper surface, and by the prosternum having one small but deep round fovea near the tip, instead of two approximate ones. Length 2.3 mm.; .09 inch.

New York; one specimen.

ZYGOBARIS n. g.

Body resembling in form a small robust *Centrinus* (e. g. *picumnus*), but very coarsely sculptured and not densely clothed with scales. Beak as long as the head and prothorax, slender, cylindrical, curved; not transversely impressed at the base; antennal grooves commencing nearly one-third from the tip, descending obliquely; eyes rather large, transverse, not convex, finely granulated, front not wider than the beak; head rather small. Antennæ with the first joint of funicle elongate, and stouter than the second; 2–7 gradually stouter, merging into the club, which is elongate-oval, pointed, pubescent and regularly annulated, the basal joint not being unduly large. Prothorax strongly narrowed in front, feebly constricted, and without postocular lobes; base bisinuate; prosternum long in front of the coxæ, which are widely separated, impressed near the front margin.

Digitized by Google

Elytra wider at base than the prothorax, humeri rounded, sides obliquely narrowed behind the humeri, tips conjointly rounded; pygidium entirely covered. Middle and hind coxæ widely separated, metasternum longer than first ventral, first and second ventral segments each equal to the third and fourth united; the fifth but little longer than the fourth; first ventral suture partially effaced, second and third slightly angulated at the sides. Legs rather long, tibiæ moderately mucronate at tip; tarsi with third joint very broad, bilobed; last joint rather long, with the claws small; connate at base.

Shining black, elytral striæ very coarsely punctured.... 1. **nitens**.
Dull black, elytral striæ deep, impunctured............. 2. **conspersa**.

1. **Z. nitens**, n. sp.

Robust, subrhomboidal, shining black, thinly sprinkled with small white scales. Beak strongly punctured, a little longer than the head and prothorax, slender, curved, not thicker at base, where it is slightly constricted. Prothorax very coarsely but not densely punctured. Elytra with fine striæ, marked with large, distant punctures, interspaces nearly flat, each with a row of equally large but more distant punctures. Beneath very coarsely punctured; claws connate for more than half their length. Length 2.5 mm.; .10 inch.

Key West, Florida; one specimen, Mr. Burgess.

2. **Z. conspersa**, n. sp.

Less robust, subrhomboidal, dull black, moderately densely clothed with yellow-brown hair, with rows of small distant white scales upon the elytra. Beak stouter than in the preceding, slightly thicker at base, cylindrical, curved, not longer than the prothorax, not impressed at base; finely punctured and pubescent. Prothorax not wider than long, gradually narrowed in front, sides nearly straight, slightly rounded near the tip; surface strongly and densely punctured; base bisinuate. Elytra wider behind the base, humeri obliquely rounded, striæ deep, interspaces elevated, flat, not very wide, densely punctured. Beneath punctured, rather densely clothed with pale brown scales; claws approximate, small, slightly connate at base. Length 2 mm.; .08 inch.

Illinois; B. D. Walsh; seven specimens. The funicle of the antennæ is stouter than in the preceding, and the club is less elongate. The general form is less robust and more rhomboidal.

BARILEPTON n. g.

Body very elongate, nearly filiform, clothed with pale scales. Beak not slender, as long as the prothorax, suddenly curved near the base, then very slightly curved; base somewhat stouter, feebly impressed; head large, convex. Antennal grooves commencing about the middle, deep, descending obliquely. Antennæ with funicle 7-jointed, first joint elongate, stouter than the second; 2–7 nearly equal in length, gradually wider, club rather large, oval, pubescent, annulated. Prothorax a little longer than wide.

Digitized by Google

sides parallel, rounded, and feebly constricted near the tip; base nearly straight. Elytra elongate, very little wider than the prothorax, conjointly rounded at tip, pygidium completely covered. Prosternum moderately long in front of the coxæ, which are very slightly separated; mesosternum rather narrow, metasternum long, hind coxæ widely separated. First, second and fifth ventral segments long, third and fourth together a little longer than the second; first suture partly obliterated at the middle; the others are distinctly curved at the sides. Legs rather slender, tibiæ feebly but distinctly mucronate; tarsi with the third joint very broad, bilobed, last joint rather long, with a single claw.

1 **B. filiforme**, n. sp.

Elongate, nearly filiform, black, clothed with small pale scales. Beak naked, shining, punctured; head thinly pubescent, punctulate. Prothorax rather densely, but not very strongly punctured, with the scales lying transversely, as in many *Centrinus*. Elytra with fine striæ, and flat, alutaceous interspaces. Legs brownish. Length 2.5–3.3 mm.; .10–.13 inch.

Virginia, Illinois, Nebraska; three specimens.

EUCHÆTES n. g.

Body resembling in form a robust *Centrinus*, but with comparatively larger prothorax, more rounded on the sides; covered with a dense crust of dirt-colored scales, and with very long stiff erect bristles. Beak nearly as long as the body, much stouter from the base to the insertion of the antennæ, then slender and strongly curved for the remaining two-thirds of the length, base constricted beneath, and somewhat protuberant; antennal grooves confluent behind; eyes transverse, finely granulated; head immersed in prothorax nearly to the eyes. Antennæ with the scape extending to the eyes, gradually thickened externally; funicle 7-jointed slender, longer than the scape; first and second joints longer, equal; seventh broader, rather closely connected with the club, which is elongate-oval, pubescent, and indistinctly annulated. Prothorax rounded on the sides, slightly bisinuate at base, narrowed and tubularly constricted at tip, without postocular lobes. Scutellum larger than usual. Elytra narrowed behind, tips separately rounded, pygidium not exposed. Prosternum truncate in front, strongly impressed transversely, not foveate, nor flattened; front coxæ very widely separated; middle and hind coxæ very widely separated; side pieces of mesothorax of the same form as in *Centrinus*; those of the metathorax narrow. First and second ventral segments very large, third and fourth united shorter than either, fifth a little longer than fourth. Legs moderate, thighs sinuate, and somewhat clavate; tibiæ nearly as long as the thighs, straight, strongly unguiculate at the outer side of the apex; tarsi rather long, slender, third joint not wider than the second; fourth joint as long as the others united, with rather large, divergent, simple claws.

This is one of the most remarkable insects in our fauna, from the length and stiffness of the bristles, which are almost spiniform.

Digitized by Google

1. **E. echidna**, n. sp.

Oval, not convex, narrowed before and behind, covered with a crust of dirt-colored scales, and with long stiff bristles, less evident on the under surface. Prothorax very uneven; elytra with narrow striæ, interspaces wide. Outer part of beak naked, brown, shining, somewhat punctured. Length 2.5 mm.; .10 inch.

Illinois; one specimen given by Dr. S. V. Summers to Dr. Horn.

PLOCAMUS n. g.

Of the form of an elongate *Centrinus*, clothed with a dense crust of gray scales, with short erect bristles intermixed. Beak as long as the head and prothorax, slender, curved, slightly and gradually thickened behind the antennæ, which are inserted one-third of the length from the base; eyes transverse, finely granulated. Antennæ similar to those of *Euchætes*, but with the funicle shorter and less slender; second joint not longer than third. Head less immersed in the prothorax; the latter is scarcely rounded on the sides, which are oblique, very strongly constricted in front, without post-ocular lobes, slightly bisinuate at base, scutellar lobe indented, and slightly emarginate. Scutellum rather larger than usual. Elytra a little wider than the prothorax, sides parallel, regularly rounded at tip. Under surface and legs, exactly as in *Euchætes*.

P. hispidulus, n. sp.

Elongate, blackish brown, densely clothed with a crust of gray scales, with short, erect pale bristles. Beak brown, naked beyond the antennæ, which are also brown. Prothorax somewhat uneven, deeply and densely punctured. Elytra somewhat clouded with darker gray, especially by a transverse spot about the middle; striæ deep, interspaces not wide, slightly convex; humeri oblique, obtuse, scarcely rounded Length 2 mm.; .08.

Southern States. I am indebted to Mr. Ulke for several specimens found at Washington, D. C. I have adopted the name under which it appears in Dej an's Catalogue.

Tribe XX. HORMOPINI.

The sub-family of genuine *Curculionidæ* fitly closes with a very anomalous insect, which while having relations with several of the earlier tribes, exhibits in addition a character which is otherwise seen in one of the sub-families of the *Calandridæ*. The eyes, namely, are very large, transverse, and coarsely granulated; they are widely separated above, but are nearly contiguous beneath. It follows from this that the antennæ in repose must be received in front of the eyes, which therefore form as it were a collar beneath; and the antennal grooves, which are deep and oblique, attaining the eyes near the upper end, are suddenly and acutely flexed beneath, forming a deep, transverse excavation in front of the eyes.

The beak is shorter than the prothorax, stout, somewhat flattened, a little wider at tip than base; the mandibles are rather flattened, acute at tip, toothed on the inner side. The gular peduncle is small and narrow, emar-

Digitized by Google

ginate at tip; the mentum is nearly round, and the ligula and palpi are not prominent; maxillæ exposed. Antennæ inserted near the tip of the beak, geniculate, scape long, slender, slightly clavate, funicle somewhat stout, first joint long, clavate, equal to the four following; 2–7 short, outer ones a little wider, club small, oval, pubescent, annulated. Prothorax rounded at the sides and base, truncate in front, without postocular lobes; prosternum feebly emarginate beneath, front coxæ contiguous. Elytra oblong-oval, a little wider than the prothorax, humeri rounded, pygidium entirely covered; scutellum small, rounded. Mesosternum moderately wide, middle coxæ separated, side pieces diagonally divided, not ascending between the elytra and base of prothorax. Metasternum rather long, side pieces narrow; hind coxæ moderately separated. Ventral segments first and second longer, separated by a slightly arcuate distinct suture; third and fourth short, separated by straight sutures; fifth as long as third and fourth united, broadly rounded behind. Legs rather short, stout; thighs thick, not clavate, sinuate beneath near the tip, not toothed; tibiæ obliquely truncate at tip, with a small hook at the inner apical angle; tarsi two-thirds as long as the tibiæ, dilated, spongy beneath, third joint broad, bilobed; fourth joint not elongate, slender, with small, approximate claws, which are slightly connate at base.

HORMOPS n. g.

The single species representing this genus and tribe in our fauna, is a small, inconspicuous black insect, thinly clothed with rather coarse yellow hair, and reminds one in general appearance of the Erirhine genus *Procas* (p. 162). The characters as above detailed are quite anomalous, and no further generic description is at present necessary. It is possible that it may have relations with some of the anomalous genera placed by Mr. Wollaston among the *Cossonidæ*, but as I have had no opportunity of studying them in nature, I can but timidly suggest the propriety of comparing this genus with those genera of *Cossonidæ* in which the eyes are disposed to become confluent beneath. The entire facies of this insect is so purely Curculionideous that (the sexual characters being unknown), I would be unwilling to place it in any other family.

1. **H. abducens**, n. sp.

Brownish black, not shining, thinly clothed with yellow pubescence, head and beak densely punctured; prothorax wider than long, rounded on the sides, feebly constricted near the tip, broadly rounded at the base; strongly but not very coarsely or densely punctured, rather shining, without distinct trace of dorsal smooth line. Elytra wider than prothorax, feebly emarginate at base; humeri rounded, sides slightly rounded, tips conjointly broadly rounded; disc somewhat flattened, striæ well impressed, slightly punctured, interspaces nearly flat, punctulate. Beneath strongly and densely punctured, last ventral more finely punctured; pubescence similar to that of the upper surface. Length 4 mm.; .15 inch.

Capron, Florida; April; Messrs. Hubbard and Schwarz; one specimen.

Digitized by Google

Subfamily V. BALANINIDÆ.

The single genus which constitutes this subfamily has been heretofore arranged as a tribe, in the vicinity of *Anthonomini*. It differs, however, from that tribe, as from all other Coleoptera, known to me by the movement of the mandibles being vertical instead of horizontal;* the mandibles are short, pyramidal and acute, and the condyle is on the upper side; the teeth seen in most Curculionidæ are wanting; the inner edge is more convexly curved than the outer, so that in the ordinary position, the points seem slightly divergent. In general appearance, as well as by the extension of the mesothoracic epimera, so as to give an oblique outline to the elytra near the base, this subfamily seems to me to approach *Centrinus* more than *Anthonomus;* the result of this obliquity is that the tenth elytral stria commences at the margin, opposite the anterior end of the metathoracic episterna, as in all *Barini*.

The beak attains in length and attenuation the greatest development; in the ♂ it is rarely shorter than the body; in the ♀ it is frequently twice the length, and is used to make the perforation into which the egg is subsequently introduced. The great thickness of the husks of the fruits (chestnuts, walnuts, hickory nuts, &c.), depredated on by these insects, necessitates a very long perforating instrument to reach the kernel, upon which the larva feeds.

The mouth organs are small, the gular peduncle very long and narrow. The antennæ are inserted a little before the middle (♂), or behind the middle (♀) of the beak, and are very long and slender; the funicle is 7-jointed; the first joint is either longer or shorter than the second, and the outer joints are gradually a little less elongated; club elongate-oval, pointed, annulated and pubescent. Eyes rather large, flat, nearly rounded, finely granulated. Prothorax rather long in front of the coxæ, which are contiguous; broadly emarginate in front, without postocular lobes; pronotum rapidly narrowed in front, sides rounded, base slightly bisinuate. Scutellum distinct. Elytra narrowed behind, tips separately rounded, pygidium more or less exposed. Side pieces of mesothorax attaining widely the base of the prothorax, and truncating the humeral outline of the elytra; metathoracic episterna narrow, dilated in front. First ventral segment longer than the second, and closely united with it; the others are nearly equal in length. Middle coxæ moderately distant, hind coxæ widely distant, not attaining the elytral margin. Legs long, thighs clavate and strongly toothed in our species; tibiæ slender; truncate at tip, not mucronate; tarsi dilated, claws divergent, toothed.

BALANINUS Germ.

I have nothing to add to the excellent synopsis of our six species given by Dr. Horn, as above cited.

B. porrectus Boh., Sch. Curc. vii, 292 still remains unknown.

*Horn, Proc. Am. Phil. Soc., 1873, 457.

Digitized by Google

Family VII. BRENTHIDÆ.

Mouth organs very different, according to genus and sex; maxillæ, ligula and palpi concealed in the species of the first sub-family in our fauna by the mentum, which in the ♂ is transverse and concave, in the ♀ narrow and convex. Mandibles in ♂ curved, flattened, pointed, more or less toothed on the inner edge; in the ♀ stout, small, pincer-shaped, toothed on the apical edge. Maxillæ exposed in *Cyladidæ* in both sexes, mentum oblong, and supported on a short gular peduncle, which is wanting in true *Brenthidæ;* mandibles short, pincer-shaped.

Antennæ inserted in lateral foveæ at a greater or less distance in front of the eyes, according to genus and sex; not geniculate, 11-jointed in true *Brenthidæ*, 10-jointed in *Cyladidæ;* outer joints finely pubescent and sensitive; basal joint stouter and a little longer than the second.

Head elongated, constricted behind, except in *Cylas;* eyes rounded, small, not granulated; labrum wanting.

Prothorax very elongate, truncate before and behind, without trace of postocular lobes; turned into a peduncle behind, with a broad basal bead; prosternum very long in front of the coxæ; prosternal sutures entirely obliterated; coxæ separate in *Brenthidæ*, conical, prominent, and contiguous in *Cylas;* in both the median suture behind the coxæ is very evident.

Mesosternum moderately long, side pieces diagonally divided, epimera pointed in front, not attaining the base of the prothorax; coxæ rounded, separate (*Brenthidæ*), nearly contiguous (*Cylas*).

Metasternum very long, episterna narrow; hind coxæ transverse oval, separated.

Elytra elongate, covering entirely the pygidium, with a fold on the inner surface close to the margin, which commences near the base, and diverges obliquely near the tip, and extends to the sutural edge in *Brenthidæ*, and nearly there in *Cylas*. Wings well developed.

Abdomen with five ventral segments, of which the first and second are very long, and united by an indistinct suture; third and fourth short, fifth a little longer, flat, rounded behind; sutures straight. Dorsal segments membranous, except the last, which is corneous; anal segment of ♂ rather large, rounded. The acute edge of the ventral segments and of the metathorax is prominent and fits, as usual, into the elytral groove.

Legs not slender, moderate in length; thighs clavate, front tibiæ sinuate, and obliquely grooved on the inner side in *Brenthidæ*, and armed with a hook on the outer tip, and a spine on the inner; middle and hind tibiæ truncate at tip, with two small fixed spurs. In *Cylas* the tibiæ are all slender, straight and not mucronate at tip. Tarsi spongy pubescent beneath, with the third joint bilobed. Claws large, simple and divergent, except in *Cylas*, where they are small and connate at base.

This highly specialized family is the last of those in which the male is provided with an additional dorsal segment. The mouth organs vary to a greater degree than they do in *Curculionidæ*, though usually the mentum is

Digitized by Google

developed to such an extent as to conceal the ligula and labial palpi. Of the genera known to me *Cylas* is the only one in which the maxillæ are exposed by the mentum not filling completely the buccal cavity, though other cases are mentioned by Lacordaire.

But what is most curious, is that while the mandibles of the ♀ preserve the pincer-form seen in many *Curculionidæ*, and the beak is slender, and in some species extremely long, for the purpose of performing its function as an accessory organ of generation,* in the ♂ the mandibles assume a flat, curved, and pointed form, resembling those of ordinary Coleoptera. This sexual character is exhibited even in those genera in which the beak of the ♂ is nearly as slender, and the mouth as small as in the ♀.

The explanation of this difference in the mandibular structure is afforded by the interesting remarks of Mr. A. R. Wallace, concerning the wonderful pugnacity of the ♂ ♂ when in proximity to the ♀. An excellent account of the assistance given by the ♂ to the ♀ when she is occupied in boring the hole in which the egg is placed, is also given by C. V. Riley,† from observations made by his correspondent W. R. Howard, of Forsyth, Missouri.

These combats, however, result in no injury to either of the parties engaged; the dense chitinous covering affords a perfect protection; the weaker male, overcome by exhaustion, eventually flees, and leaves to his more vigorous victor the honorable task of guarding and assisting the fair object of strife in her efforts to preserve the species.

The habits, therefore, of these insects, as well as their peculiarities of structure, deserve a closer attention than has yet been given to them.

The smooth eyes, the reticulations of which are seen only through the transparent integument, and the form of the front tibiæ, indicate a resemblance, though a remote one, to *Rhyssodidæ*, such as might perhaps exist among objects of quite different nature originating in the same period of time. The geographical distribution of the *Brenthidæ* is also favorable to the idea that they represent a tolerably ancient form of life.

The great extension of the longitudinal axis of the body exceeds in some members of this family any proportion that occurs in other *Coleoptera;* and it is singular to see that a character, which usually indicates feebleness of development, is here associated with densely chitinized integuments, and great complication of domestic life.

The family divides itself naturally into two subfamilies, the characters of which have been sufficiently exposed above.

Antennæ 11-jointed, last joint oval, pointed, not larger, **BRENTHIDÆ.**
Antennæ 10-jointed; last joint very elongate,......... **CYLADIDÆ.**

*Harris, Ins. Inj. Veg. 3d ed. 63; Wallace, Malay Archipelago (ed. Harper), p. 482; Riley, Sixth Annual Report, Ins. of Missouri, p. 115. These authors mention that the ♀ makes with her beak deep perforations in the tree, and deposits an egg in each one of them; Lec., Am. Journ. Sc. and Arts, 1867.

†Sixth Annual Report on the Noxious, &c., Insects of Missouri, 1874, p. 415.

Digitized by Google

Subfamily I. BRENTHIDÆ (genuini).

Of this family two genera belong in the faunal limits treated of in this memoir, though one of them (*Brenthus*), is in a political sense extra-limital, having occurred in Lower California.

These two genera represent in the arrangement of Lacordaire separate groups, but in the plan of subordination of characters herein adopted, they seem to indicate what I have called tribes, which may be distinguished by the sexual and other differences in the head, as well as by the form of the prothorax.

Beak very dissimilar in the two sexes; antennæ not very remote from the eyes, rather slender, not compressed, nor clavate; prothorax convex, not grooved.. ARRHENODINI.

Beak slender in both sexes; antennæ far distant from the eyes, somewhat thickened and stouter externally; prothorax deeply grooved towards the base........... BRENTHINI.

Tribe I. ARRHENODINI.

The genus *Eupsalis*, represented in our fauna by a single species, differs from *Arrhenodes* by the brilliant lustre of the surface, and by the hind part of the head being less prominent; in view of the magnitude of the variations in the ♂ ♂, which I have mentioned below, I have great doubt of the generic value of these characters; nevertheless, my opinion can only be tested by a careful study of foreign species, which would interrupt the progress of the present memoir, and is, moreover, not essential for the elucidation of our own fauna.

The distribution of *Eupsalis*, even as thus limited, is remarkable; one species in North America, one species in Guinea, and one in Madagascar, and perhaps one in Brazil. It is worthy of remark in this connection, that the genus *Amorphocephalus*, the only Brenthide found in Europe, is also represented in Australia.*

EUPSALIS Lac.

1. **E. minuta** Riley, 6th Mo. Report, 113; (larva correctly determined, described and figured); *Curculio minutus* Drury, Ins. i, 95, Tab. 42, f. 3, 7, name given in index, vol. ii, (♀); Herbst, Käfer, vii, 200; Tab. 108, f. 9, (♀); Oliv. Enc. Méth. ii, 192; *B. maxillosus* Oliv. Ins. iv, No. 84, Tab. 1, f. 1, and Tab. 2, f. 17, (♂♀); Gyll., Sch. Curc. i, 326.

B. septemtrionis Herbst, Käfer, vii, 183, Tab. 108, f. 5, (♂); *B. brunneus* Panzer, ed. Voet. iv, 44; *B. distans* Panzer, ibid.

B. (*Arrhenodes*) *septemtrionis* Harris, Ins. Inj. Veg. 3d ed. 68; (larva erroneously determined and described); *Eupsalis maxillosus* Horn, Tr. Am. Ent. Soc. iv, 127.

Abundant from Lake Superior to Texas, and from New England to Colorado; bores into the heart wood of various oaks, usually after they have been felled, though sometimes while the tree is still living; the white, the

*Lacordaire, Gen. Col. vii, 423.

Digitized by Google

black, the red and the post oaks are mentioned as those which are known to be attacked. By some curious inadvertence, Olivier in the Encyclopédie Méthodique cites for this species No. 84, plate ii, f. 9; a totally distinct species, which in the text (v, 439) is named *B. militaris*.

A description of this very well known insect is here unnecessary, but a notice of the variations which I have observed in the head of the males may be of interest.

The females vary in length from 6.5 to 14 mm.; .25 to .56 inch., from the eyes to the tip of the elytra. The head is rather strongly constricted immediately behind the eyes, which are convex and prominent. Immediately in front of each eye is a deep fovea; and in advance of them is a deep frontal excavation; the ridges above the insertion of the antennæ are prominent, and not angulated; the beak in front of the antennæ is as long as the joints 1–9 of the antennæ, which are shorter and stouter than in the ♂.

The males vary in length from 7.2 to 17 mm.; .28–.67 inch, from the eyes to the tip of the elytra. The head affects three different forms, which seem to be independent of size:

1. The head is suddenly, but not strongly constricted behind the eyes, with the lateral angles obtuse, but distinctly outlined; the ridges above the antennæ are very prominent, angulated behind, and separated from the front by a deep impression; the frontal impression is large and deep, and the median elevation in it is feeble; the beak in front of the antennæ is strongly dilated, much wider than long, with scattered elevated granules, and with a well developed ridge each side, which is suddenly more elevated at its posterior end; there are also two shallow impressions. The mandibles are as long as the beak in front of the antennæ; the cusp on the inner side is distinct and the apex of the right mandible has three cusps, that of the right but two. This form occurs in Michigan and Georgia.

2. The beak in front of the antennæ is not transverse, but fully as wide as long; the other characters as in (1). This form occurs in Kansas and Texas.

3. The beak in front of the antennæ is nearly twice as long as wide, the lateral ridges less developed, the granulations more numerous, the mandibles comparatively shorter and stouter; the frontal impression more elongated, with the median elevation more distinct; the ridges above the insertion of the antennæ are less prominent, not angulated behind, and the head is less suddenly constricted behind the eyes, with the angles so much rounded as to be nearly effaced.

These characters are somewhat similar, as regards the development of the supra-antennal ridges to those observed in *Lucanidæ*, but in the variation of the length of the beak are rather anomalous. They indicate, however, the propriety of recasting the classification of this family, and defining the genera and species by the invariable characters of the female, rather than by the perhaps individual modifications of the male.

The measurements given above show a slight average superiority of size in the male, but not sufficient to warrant any generalization in favor of

Digitized by Google

sexual selection, produced by the bloodless combats of these insects; which seem, so far as the records go, to be actuated rather by chivalric sentiment, than by animal passion.

Tribe II. BRENTHINI.

Two species of *Brenthus* collected by Mr. Xántus, at Cape San Lucas, Lower California, which are closely allied to Mexican species, have been fully described by Dr. Horn.* I observe in the males also great variation in the form of the head in different individuals, although the beak, though shorter, is as slender in the ♂ as in the ♀, and the mandibles are equally small, but different in form; the distance from the eyes to the insertion of the antennæ is proportionally longer in the larger males.

The head is deeply excavated beneath, just in front of the neck, in *B. peninsularis*, while it is only slightly so in *B. lucanus*. In *B. mexicanus* there is a short but deep groove in the same position. The front femora alone are toothed in *B. mexicanus* and *lucanus*, while they are all toothed in *peninsularis*.

Subfamily II. CYLADIDÆ.

This sub-family represents the tribe *Cylades*, of Lacordaire, placed by him between *Eurhynchus* and *Apion*, and consists of but two genera, one of which, *Cylas*, occurs in Asia and Africa, while the other, *Myrmecacelus*, is found in Australia. I have sufficiently exposed the characters of this subfamily in the description of the family, and the singular form of the antennæ, as well as the very peculiar appearance of the insect, will enable it to be easily recognized.

The relations of these insects with *Brenthidæ* were well recognized by Fabricius, Latreille and Olivier, and I know not for what reason they have been lost sight of by more recent observers.

CYLAS Latr.

1. **C. formicarius** Olivier, Ent. 84, bis, p. 446; Tab. 2, f. 19; *Brentus form.* Fabr. Syst. El. ii, 549; Ent. Syst. Suppl. 174; *Attelabus form.* Fabr. Ent. Syst. Suppl. 163; *C. turcipennis* Boh., Sch. Curc. i, 369. *Otidocephalus elegantulus* Summers, New Orleans Home Journal, Jan. and Dec. 1875.

Cochin China, India, Madagascar, Cuba and Louisiana. Depredates on the roots of sweet-potato (*Convolvulus batata*).

Body very elongate, smooth and shining, ferruginous, with the elytra bluish black. Head and beak dusky, the latter twice as long as the head, stout, cylindrical, nearly straight, finely punctured towards the base; antennæ inserted near the middle; eyes smooth, rounded, reticulations very distinct beneath the epidermis. Prothorax twice as long as wide, not constricted in front, but very deeply strangulated at the posterior third. Elytra

*Trans. Am. Ent. Soc. iv, 128.

Digitized by Google

elongate-oval, a little wider than the prothorax, very convex, humeri very oblique; surface feebly and sparsely punctulate. Under surface of trunk and abdomen dusky. Length 5.8 mm.; 2.3 inch.

♂. Last joint of antennæ longer than the others united.

♀. Last joint of antennæ shorter than the others united.

The species of this genus are declared by Lacordaire to be apterous, and so one would naturally suppose from the form of the body. On dissec ion, however, the wings are found to be very well developed, and the elytra not connate.

Family VIII. CALANDRIDÆ.

Mouth cavity variable according to subfamily, as follows:

1. Gular peduncle very long, concealing the mentum and ligula, buccal fissures narrow and long; mandibles compressed, wi.h three apical teeth in *Calandridæ* (*genuini*).

2. Floor of the mouth so prolonged that all of the organs are concealed, except the mandibles, which are convex on the inner face, with three apical teeth, and usually diverge externally in *Rhinidæ*.

3. Gular peduncle rather broad, mentum trapezoidal, transverse; maxillary palpi rather large; mandibles flattened, curved, with the apex acute, and one prominent tooth on the inner edge, in *Cossonidæ*.

Antennæ geniculate, inserted near the base of the beak (*Calandridæ*), or about the middle (*Rhinidæ* and *Cossonidæ*); scape long, funicle varying from four to seven joints; club variable, with the basal part, and sometimes nearly the whole surface shining, not sensitive: oval and annulated as usual in *Cossonidæ*.

Head porrected, beak at most capable of being deflexed vertically, never narrowed behind the eyes; beak sometimes long, sometimes short; eyes sometimes small, sometimes very large and transverse, contiguous beneath (*Rhinidæ*); antennal grooves very short, and not receiving the scape in *Calandridæ*, suddenly deflexed under the eyes, and receiving the scape in *Cossonidæ*.

Prothorax truncate in front, not emarginate beneath, prosternum long in front of the coxæ, which are separated; prosternal sutures effaced; the transverse suture between the coxæ is wanting in *Calandridæ* and *Cossonidæ*, but distinct in *Rhinidæ*.

Mesosternum triangular, truncate behind, side pieces varying according to genus and tribe; middle coxæ separated, cavities rounded.

Metasternum usually long, episterna varying in breadth, broader in front, epimera large in some *Calandridæ*, small in other genera and subfamilies; hind coxæ transverse, oval, not attaining the side of the abdomen.

Elytra without epipleuræ, exposing the pygidium in *Calandridæ*, covering it more or less completely in the other subfamilies; on the inner surface the elevated fold commences near the base, continues parallel and close to the margin as far as the posterior curvature, where it diverges and becomes

Digitized by Google

obsolete. The space between the ridge and the margin has a pearly lustre, and may possibly serve as a stridulating organ; in the *Cossoninæ* this ridge diverges much less and becomes obsolete sooner.

Abdomen with five ventral segments, of which the first and second are longer, with the suture nearly obliterated at the middle in *Calandridæ*, but deep and entire in *Rhinidæ;* in *Cossonidæ* they are very long, and the suture is effaced at the middle; the third and fourth segments are short, and the sutures straight and deeply impressed; the fifth is about as long as the third and fourth united, and is rounded behind. The dorsal segments are membranous, except the last, or pygidium, which is large, nearly perpendicular in *Calandridæ*, obliquely deflexed in the other subfamilies; the anal segment of the ♂ is quadrate and retractile in *Calandridæ* and *Rhinidæ*, broader and less retractile in *Cossonidæ*, but not continuous with the pygidium as in *Curculionidæ* and *Brenthidæ;* the lateral edge of the metathorax and of the ventral segments is sharp and fits into the lateral groove of the inner surface of the elytra; in the *Cossonidæ* this edge continues on and around the last ventral, thereby showing a tendency towards the modification finally perfected in the *Scolytidæ*, and of which we have already seen traces in the *Brenthidæ*.

Legs moderate, varying though not greatly, according to genus; thighs usually stoutly clavate, not toothed; tibiæ rather short, strongly unguiculate at the outer angle. Tarsi frequently narrow and not brush-like beneath; third joint sometimes bilobed, (*Rhinidæ*) sometimes broad patellate, and not emarginate, (certain *Sphenophori*); claws divergent, simple.

I have embraced in this family several very distinct forms which agree with *Curculionidæ* in general characters, but differ in having the genital segment of the ♂ not articulated directly at the end of the last dorsal, but either retractile or concealed under it. While the mouth organs of the *Cossonidæ* are similar to those of ordinary *Curculionidæ*, and submit to modifications similar to those of *Hylobiini* for instance, in the other subfamilies there are specializations which do not otherwise occur among Rhynchophora.

With regard to the affinities of the members of this family, it may be said, in general terms, that the *Calandridæ* show an alliance with the *Barini;* the *Rhinidæ* continue the specialization still farther, and have not a direct resemblance to any other tribe. The *Cossonidæ* seem to be a connecting line from *Hylobiini* to *Scolytidæ*, to which they approach very closely in *Rhyncolus*.

Three subfamilies occur in our fauna, the characters of which have been sufficiently indicated above: the following table will enable them to be readily distinguished.

Buccal cavity elongate, peduncle of mentum elongate, narrow: pygidium exposed..................	CALANDRIDÆ.
Buccal cavity entirely at the apex of the beak; pygidium covered..............................	RHINIDÆ.
Buccal cavity normal, peduncle of mentum short, oral organs exposed; pygidium covered......	COSSONIDÆ.

Digitized by Google

Subfamily I. CALANDRIDÆ.

An excellent synopsis of the species of this subfamily, as represented in our fauna is given by Dr. Horn in the Proceedings of this Society for 1873, commencing on page 407. I have but a few new species of *Sphenophorus* to add, which seem scarcely worth describing at the present time. I shall therefore confine myself to giving at greater length my views on the subdivision of the subfamily into tribes and genera, which do not differ essentially from those developed by Lacordaire, and followed by Horn.

Side pieces of metathorax very wide, epimera large..................................	RHYNCHOPHORINI.
Side pieces of metathorax moderate, or narrow:	
Mesosthoracic epimera broadly truncate externally; club of antennæ wedge-shaped.	SPHENOPHORINI.
Mesothoracic epimera acute externally; club of antennæ oval..................	CALANDRINI

Tribe I. RHYNCHOPHORINI.

The species of this tribe are of large size, and with the exception of *Rhynchophorus*, have the mandibles turned outwards as in the *Rhinidæ;* in the genus just mentioned, the mandibles are of the usual pincer-form with three small apical teeth. The funicle of the antennæ consists of six perfoliate joints, strongly constricted at the outer end; the club is transverse, trapezoidal, corneous, with the terminal face flat, spongy and sensitive.

One species, *R. cruentatus*, represents this species in the Southern States. It is parasitic on *Chamærops palmetto.* In consequence of the extension of the mesothoracic epimera upwards, the humeral portion of the elytra is truncated, as in *Barini.* The third joint of the tarsi is but little wider than the second, not emarginate, fringed at the apical margin beneath. In the ♂ the tibiæ, and to a less extent the thighs are densely fringed with long yellow hair on the inner side: in the ♀ the hairs are much less dense. The genital segment is sometimes protruded; it is nearly smooth, and finely channeled above in both sexes, but is longer and narrower in the ♀, in which sex also the pygidium is more flattened, and more obliquely narrowed at the tip.

Tribe II. SPHENOPHORINI.

The species of this tribe are rarely large, but never very small. The mandibles are always pincer-shaped, with three apical teeth. The mesothoracic epimera are large, and truncate at the outer side, so that the outline of the elytra near the base is straight, and not oblique as in the preceding tribe; the metathoracic episterna are rather narrow, and the epimera small, though quite obvious.

Three genera have been observed in our fauna.

Spongy portion of antennal club flat............	SCYPHOPHORUS.
" " " " convex.............	2.

Digitized by Google

2. Anterior coxæ widely distant...............	METAMASIUS.
" " narrowly separated...........	3.
3. Third joint of tarsi patellate, spongy surface not divided.............................	CACTOPHAGUS.
Third joint of tarsi patellate, spongy, narrowly divided....................................	RHODOBÆNUS.
Third joint of tarsi pilose at the sides or glabrous.	SPHENOPHORUS.

SCYPHOPHORUS Sch.

The species of this genus are parasitic on *Yucca*, and seem to me rather opinionative than actual.

1. **S. acupunctatus** is found in California, Colorado, and Mexico; it is somewhat shining, with the prothorax moderately constricted at tip, and the lateral punctures elevated. *S. interstitialis* of Cuba, has the same punctuation of prothorax, but a little stronger, and the apical constriction is less marked; the lustre is more dull. *S. robustior* Horn, from Texas, has the form of prothorax of *acupunctatus*, but the punctures are coarser, and the lateral ones are less elevated; the lustre is also dull as in *S. interstitialis*.

2. **S. yuccæ** Horn, from California, is quite distinct by the more depressed upper surface, and the single rows of punctures on the interspaces of the elytra.

METAMASIUS Horn.

M. sericeus Horn, Pr. Am. Phil. Soc. 1873, 410. *Calandra sericea* Latr. Humb. and Bonpl. Voyage, v, 41, Tab. 22, f. 4; Oliv. 83, p. 84; Tab. 28, f. 109; *Sphenophorus ser.* Gyll., Sch. Curc. iv, 896.

This species occurs in California and Arizona; also in Cuba, Mexico, and S. America, as far as Peru.

SPHENOPHORUS Sch.

The species *S. 13-punctatus* and *validus* contained in Horn's Group ii, should each constitute a distinct genus; the other species, in which the third joint of the tarsi is not spongy beneath, but merely pilose, sometimes broad, sometimes narrow, might be regarded as constituting but one genus.

CACTOPHAGUS n. g.

I would separate as a distinct genus a species of large size, and dull velvety black color, which differs from *Sphenophorus*, by the absence of inequalities or coarse sculpture, and by the third joint of the tarsi being somewhat transverse, and uniformly densely spongy beneath; the first and second joints are narrow, and glabrous beneath. The tibiæ are slender, not sinuate, and the outer part of the tip is regularly rounded, not at all truncate, or angulated. The gular peduncle, though deeply channeled, is regularly rounded at the end, not abruptly subtruncate as in *Sphenophorus*; whereby the beak remains cylindrical, and is not at all compressed at tip.

Digitized by Google

1. **C. validus.** *Sphenophorus val.* Lec., Pr. Ac. Nat. Sc. Phila. 1858, 80; Horn, Pr. Am. Phil. Soc. 1873, 415; *S. procerus* Lec., Pr. Ac. 1858, 80.

California, from San Diego to Cape San Lucas; Arizona, Mexico. The synonym belongs to a form in which the apical constriction of the prothorax is less obvious; this variation serves to confirm the opinion above expressed regarding the species of *Scyphophorus*. The specimens were found exclusively under decaying Opuntia leaves.

RHODOBÆNUS n. g.

I would also separate as distinct the usually red species with black spots, which agree with *Cactophagus* in the form of the gular peduncle, but differ in the tibiæ subtruncate at the tip, with the outer angle obtuse, but distinct, the third joint of the tarsi is equally broad and spongy beneath, but the brush is divided by a narrow line; the first joint is hairy at the tips, while the second is densely hairy, with a narrow median line. The elevations above the insertion of the antennæ are much stronger, and the scape of the latter comparatively longer. The mesosternum is also narrower than the other genera. The species are found on flowers, mostly rose-bushes; but two are known to me in our fauna; the first is red, with black spots; the second brown, irrorate with grayish round spots, which surround the punctures.

1. **S. tredecimpunctatus.** *Curculio tred.* Illiger, Schneider's Mag. v, 613; for synonymy see Horn, l. c. 414.

Atlantic district, to Colorado, also in Mexico, and South America.

2. **S. pustulosus** Gyll., Sch. Curc. iv, 923; Horn, l. c. 415.

Arizona; also in Mexico.

Tribe III. CALANDRINI.

This tribe consists of small species, in which the mandibles are pincer-shaped, and not everted; the club of the antennæ not compressed, and the mesothoracic epimera transverse, acute at the outer end, and intervening between the humeral part of the elytra and the base of the prothorax. The anterior part of the last dorsal segment of the abdomen is channeled for the reception of the sutural edge of the elytra, almost as in *Anthribidæ*. This is a very peculiar character, and I find no trace of it in the other genera in our fauna.

CALANDRA Clairv.

This genus differs from the others contained in the tribe, but not represented in our fauna, by the antennal club being oval, the corneous part separated from the sensitive part by a transverse line; the sensitive part being convex, and somewhat pointed. The body is narrow, and elongate, quite different to that observed in the genera of the two preceding tribes, rather resembling *Rhina* in miniature.

Three species occur in our fauna; they have been distributed in the cereal grains upon which they depredate, so that their original habitat cannot

Digitized by Google

be known with certainty. Dr. Horn mentions that from time to time o'her species have been introduced by ships from tropical ports, but fortunately they have not yet become naturalized.

1. **C. oryzæ** Fabr., Syst. El. ii, 438, &c.; Horn, l. c. 430; *Curculio oryzæ* Linn. Amœn. Acad. vi, 395, &c.; *Rhynchophorus oryzæ* Herbst. Käfer, vi, 18, Tab. 60, f. 9; *Sitophilus oryzæ* Gyll., Sch. Curc. iv, 981, (cum synon. and bibliographia).

Found in every part of the globe; universally distributed by commerce, and said to have been originally derived from Asia; it affects rice, wheat, and Indian corn (maize). The surface is dull, and the prothorax densely punctured; the elytra are usually ornamented with four red spots, but are sometimes red, with the suture, side margin and tip darker.

2. **C. remotepunctata** Horn, Pr. Am. Phil. Soc. 1873, 430; *Sitophilus rem.* Gyll., Sch. Curc. iv, 979.

Atlantic district, extending into Arizona. The surface is somewhat shining, and the prothorax is more coarsely and less densely punctured.

3. **C. granaria** Fabr., Syst. El. ii, 437; Oliv., 83, p. 95; Tab. 16, f. 196, &c.; *Curculio granarius* Linn., Fn. Suec. 587; Syst. Nat. 12th, ii, 608, &c.; *Sitophilus granarius* Gyll., Sch. Curc. iv, 977, cum synon. plur.

Missouri, depredating on wheat; C. V. Riley. Very similar to the preceding, but the punctures of the prothorax are smaller, and the striæ of the elytra much finer and less coarsely punctured.

Subfamily II. RHINIDÆ.

This subfamily corresponds nearly if not exactly with Lacordaire's tribe *Sipalides*, and the essential differences between it and the *Calandridæ* are in the position of the buccal opening which is entirely at the end of the beak, not extending upon the under surface; the pygidium is not large and perpendicularly declivous as in the last subfamily, but covered by the elytra, which are conjointly rounded at tip; another character also separates it from *Calandridæ* (though not from Lacordaire's tribes *Strombosceridès*, and *Oxyrhynchides*, which are not represented in our fauna, and are unknown to me in nature); the eyes are strongly granulated, very large, and confluent on the under surface of the head.

In nearly all the genera mentioned by Lacordaire, the mandibles are convex on the inner face, and the apical teeth are everted, though this is probably a group or generic character as in certain tribes of *Calandridæ*. The club of the antennæ varies in form according to genus, and is not annulated. The tarsi also vary, the third joint being narrow in some genera, wide and bilobed in others.

But one representative occurs in our fauna, which indicates a new genus; allied to *Rhina* and *Harpacterus*.

YUCCABORUS n. g.

The body is elongate, glabrous, subcylindrical, resembling in appearance a gigantic *Cossonidæ*; the beak is straight, as long as the prothorax, usually

Digitized by Google

flexed perpendicularly downwards; sculptured beneath with three longitudinal grooves; antennal grooves very short; eyes transverse, coarsely granulated, contiguous beneath, but widely distant above, and not extending to the upper surface of the cranium. Antennæ with scape reaching the eyes; funicle 6-jointed, longer than the scape; club elongate-oval, as long as the four preceding joints; spongy part as large as the corneous part, and separated from it by angulated lines, so as to extend farther upon the sides than upon the faces of the club, which is slightly compressed.

Prothorax longer than wide, rounded on the sides, a little narrower at tip than at base, and constricted; truncate before and behind. Scutellum small, rounded. Elytra with shallow punctured striæ, interspaces wide, sparsely punctured; conjointly rounded at tip, pygidium slightly prominent. Legs slender, thighs not clavate, tibiæ subsinuate on the inner side, and feebly serrate, especially the front pair; outer angle obtuse, indistinct, inner angle strongly unguiculate; tarsi slender; third joint a little wider, bilobed, not spongy beneath, but smooth and glabrous like the others.

This genus differs from the two above named by the form of the antennal club, by the eyes being widely distant above, and by the third tarsal joint much smaller, not spongy beneath.

1. **Y. frontalis.** *Rhina frontalis* Lec., Trans. Am. Ent. Soc. 1874, 70.

Mojave Desert, Cal.; under bark of Yucca; G. R. Crotch. Length 8–11 mm.; .32–.45 inch. I expressed my opinion when describing this species, that it might indicate a distinct genus; but my knowledge of *Rhynchophora* at that time was not sufficient to enable me to properly define it.

Subfamily III. COSSONIDÆ.

The abnormal form of mouth seen in the two preceding subfamilies is here replaced by the ordinary buccal cavity and mouth organs seen in *Curculionidæ*. The gular peduncle is rather broad, not very long, the mentum and ligula with its palpi are distinct, and moderately large, and the maxillæ and palpi are well developed. The beak varies greatly, being sometimes rather long, and moderately slender, sometimes so short and stout as to become indistinct. The antennæ are inserted at a variable distance, being sometimes basal, sometimes nearly apical; the scape generally extends beyond the eyes; the funicle has from four to seven joints; the club is small, oval, partly corneous in some genera, and but feebly annulated. The front coxæ are sometimes widely separated, sometimes almost contiguous. The thighs are unarmed, and the tibiæ are armed in our genera with a long curved spine at the inner apical angle; the tarsi are variable, the third joint is usually not broader; in one genus, *Dryophthorus*, by an exception otherwise unknown in the family, and repeated again only in *Platypus* and some other genera among the *Scolytidæ*, the tarsi are distinctly 5-jointed.

Neglecting the number of joints in the funicle of the antennæ as being rather of generic than tribal value, I would divide the few genera represented in our fauna as follows:

Digitized by Google

Beak long, not dilated at tip; body uneven, covered with a crust............................	DRYOPHTHORINI.
Beak long, or moderate, usually dilated at the end, with rapidly descending antennal grooves, front coxæ distant, body sometimes depressed..	COSSONINI.
Beak usually short, always continuous with the front, and equally stout; front coxæ approximate; body cylindrical.......................	RHYNCOLINI.

Tribe I. DRYOPHTHORINI.

I have associated with *Dryophthorus* two other genera which have but little in common with it or with each other, except the following characters, by which they differ from other *Cossonidæ*, and approach other groups of *Rhynchophora*. The beak is longer than the head, not very stout, cylindrical, not dilated at tip, and the buccal cavity is smaller; the gular peduncle and mentum are smaller and narrower than in the other tribes. The tibiæ are slender, not at all dilated, and the terminal hook is long. The body is coarsely sculptured, and covered with a dirt-colored crust.

Two groups are indicated by the three genera before me.

Metasternum long; funicle 4-jointed....................	Dryophthori.
Metasternum long or short; funicle 5–7 jointed..........	Dryotribi.

Group I. Dryophthori.

A single small species, represents this group in our fauna. It resembles in form *Calandra*, rather than any genus of *Cossonidæ* known to me. The antennal club is rounded, oval, corneous, except the tip, which is spongy and not annulated; the joints of the funicle are only four, while those of the tarsi are distinctly five, though in the South European *Chærorhinus*, according to description, this anomaly disappears, and the tarsi are 4-jointed. The metasternum is long and the side pieces are narrow; the first, second and fifth ventral segments are very large; third and fourth excessively short, shorter in fact than in any other genus I have examined. The antennæ are inserted very near the eyes, which are coarsely granulated and transverse.

DRYOPHTHORUS Sch.

1. **D. corticalis** Say, Curc. 24; ed. Lec. i, 292; Boh., Sch. Curc. iv, 1089; Horn, Pr. Am. Phil. Soc. 1873, 431.

Atlantic district generally; found under bark. Boheman mentions the occurrence in California of *D. bituberculatus*, which is widely distributed over the islands of the South Pacific; Sandwich Islands and New Zealand. Its extension to California is doubtful.

Group Dryotribi.

Two species of very remarkable genera are here represented; the first bears some resemblance to *Dryophthorus*, and in the arrangement of Wol-

Digitized by Google

laston* would be placed in the first group of his *Pentarthrides*. The second genus would probably go near *Lymantes*, which is thus far unknown to us, and may perhaps have some relation to the European *Styphloderes*.

Besides the more slender beak, and the crusty covering, these insects differ from those of the following two tribes by the head being rather peculiarly constricted behind the eyes, which are small, rounded and very coarsely granulated; the result of this form of head is that the eyes are situated on the beak, instead of at the sides of the cranium proper. The scutellum is not visible in either of our genera, and I am inclined to believe that this will be found a character of the group, permitting the association of forms now widely separated.

Antennæ with 5-jointed funicle........................**DRYOTRIBUS.**
" " 7-jointed " .... **GONONOTUS.**

DRYOTRIBUS Horn.

1. **D. mimeticus** Horn, Pr. Am. Phil. Soc. 1873, 433.

Key West, Florida, February; Mr. Burgess. The eyes are nearly round, and composed, as observed by Dr. Horn, of about twenty lenses; the constriction is about half way between the eyes and the apex of the prothorax. The scape of the antennæ extends to the hind margin of the eye.

GONONOTUS n. g.

Beak rather slender, as long as the prothorax, moderately curved, very coarsely sculptured, separated from the head by a transverse constriction immediately behind the eyes, which are small, convex, prominent, and composed of about thirty to thirty-five lenses. Antennæ inserted about one third from the end of the beak, scape slender, extending to the eyes, funicle 7-jointed, longer than the scape, rather slender, first joint longer and stouter; club small, oval, rather shining, thinly pubescent, annulated on the outer half; antennal grooves lateral, deep, extending to the lower margin of the eyes. Head small, very short. Prothorax about as long as wide, uneven, coarsely sculptured, sides bisinuate and suddenly constricted far from the tip, thus causing two lateral protuberances, one near the base, and another more prominent in front of the middle. Elytra elongate-oval, a little wider than the prothorax, subcostate, with intervening shallow grooves, costæ with rows of extremely short and indistinct hairs. Prosternum narrow, front coxæ narrowly separated, middle coxæ moderately separated, hind coxæ very widely separated. Mesosternum short, side pieces narrow. First, second and fifth ventral segments long, third and fourth united about equal to the fifth, first suture obliterated in great part. Legs slender, rather long, thighs slightly clavate, terminal hook of tibiæ smaller than usual in this sub-family; tarsi short, rather stout, third joint broader, bilobed and hairy beneath; last joint more thickened at tip than usual, claws small, divergent.

* Genera of the *Cossonidæ*: Trans. Ent. Soc. London, 1873, p. 434.

Digitized by Google

1. **G. lutosus**, n. sp.

Dull pitchy black, without lustre, and clothed with a thin crust of dark color. Head and beak very coarsely rugosely punctured. Prothorax coarsely granulate, each granule with a central puncture; disc with two broad shallow grooves, or rather with three fine but not prominent carinæ. Elytra with shallow cribrate grooves, interspaces narrow, carinate, alternately a little more elevated. Beneath very coarsely punctured; antennæ testaceous. Length 2.5 mm.; .10 inch.

Haulover, Florida, March 16th; Messrs. Hubbard and Schwarz. A very singular insect, of which I hope more specimens may be obtained than the single one I have examined.

Tribe II. COSSONINI.

I would associate as a distinct tribe certain other genera, which have not the body covered with a crust, but shining and bare; some of the foreign genera are more or less setose, but ours are glabrous.

The beak is never very short, and is frequently dilated at tip; the antennæ are inserted near the tip, or at the middle; the antennal grooves frequently descend rapidly on the sides of the beak, and sometimes are directed towards the eyes, but the antennæ are not received in repose in a deep transverse gular groove as in the next tribe. The club varies in form, and in our genera the funicle is 7-jointed; whether any of the genera of other countries, with less number of joints in the funicle, belong to the tribe as here constituted, must be determined by subsequent investigations.

The arrangement here proposed differs radically from that offered by Mr. Wollaston, and, if found in accordance with natural affinities, will result in a great reduction of the number of genera.

The genera I recognize in our fauna are as follows:

Body not depressed, beak not dilated at tip..	2.
Body very depressed, beak not dilated at tip,	HOMALOXENUS.
Body depressed, beak dilated at tip; antennæ inserted near the tip, grooves descending rapidly	COSSONUS.
2. Antennæ inserted near the middle of the beak................................	3.
Antennæ inserted near the tip of the beak; funicle stout, club moderately small...	MACRORHYNCOLUS.
Antennæ inserted near the base of the beak, body very narrow....................	MACRANCYLUS.
3. Antennal grooves descending obliquely,	4.
" " directed towards the eyes	ALLOMIMUS
4. Body pale, very elongate; funicle slender, club large..........................	STENOMIMUS.
Body black, less elongate: funicle gradually stouter, club large................	CAULOPHILUS.
Body black, less elongate, funicle very stout, club small.....................	MESITES.

Digitized by Google

HOMALOXENUS Wollaston.

H. dentipes Woll., Tr. Ent. Soc. London, 1873, 615.

Florida: a single specimen, collected and kindly given to me by Baron R. Osten Sacken, agrees so perfectly with the description of Mr. Wollaston of his specimen from S. Domingo, that I am not warranted in considering it as distinct. The only difference seems to be that in my specimen the thighs, though very thick, are hardly perceptibly toothed; this character may, however, be sexual. The insect will be easily recognized by the very depressed form, brown color, with dull lustre; very slender beak. as long as the prothorax; slender antennæ; scarcely mucronate tibiæ, and very widely dilated and bilobed third tarsal joint; characters of rare occurrence in the present sub-family, but combined with a general appearance which renders the affinities with this tribe unmistakable.

COSSONUS Clairv. (emend. Wollaston.)

To this genus, as now restricted, belong the eight species comprised in group A, Horn, Pr. Am. Phil. Soc. 437. An excellent table of differences. also the bibliography and full descriptions are there given. The funicle of the antennæ becomes gradually stouter, and the dilatations of the apex of the beak less evident from the first species (*platalea*), to the eighth (*impressifrons*), thus establishing an imperceptible transition to *Borophlæus* Woll. So far as I may judge without comparison of specimens, I do not see why *B. minor* Woll. Trans. Ent. Soc. London, 1873, 627, may not be referred to the species determined by Horn as *C. corticola* Say.

MACRORHYNCOLUS Wollaston.

To this genus I refer the Californian *Rhyncolus protractus* Horn, Pr. Am. Phil. Soc. 1873, 444, which differs from the true *Rhyncoli*, not only as stated by Horn, in the widely separated front coxæ and linear form, but by the longer cylindrical beak, which is quite distinctly separated from the head. The third joint of the tarsi is narrow and feebly bilobed.

MACRANCYLUS n. g.

The number of genera in this tribe has been increased to such an extent as to render them extremely difficult to recognize. I am quite unwilling to add to the names already published, until an attempt has been made to combine them into larger groups. It is for this reason that I regret to propose this genus for an extremely slender but cylindrical (not depressed) species, which has the beak stout, not separated from the front, gradually but slightly tapering externally. The antennal grooves commence about the middle of the beak, and the antennæ are inserted behind the middle; the scape is long, extending to the back part of the eyes, and is rather suddenly bent and thickened from the middle to the tip; the funicle is moderately stout, the first joint larger and thicker; the remaining joints short, closely united, gradually but very slightly broader; club oval, pointed, rather small, distinctly annulated in the outer half. The antennal grooves

Digitized by Google

are deep and directed against the eyes, which are round, moderate in size, and finely granulated. The front coxæ are widely separated; the tibiæ gradually dilated and the front pair are pubescent towards the tip; a distinct spine is seen at the inner apical angle; terminal hook long; tarsi with rather broad joints, third a little wider, feebly bilobed, last joint longer than the others united; claws large, divergent. Scutellum distinct, elytra with punctured striæ, which are deeply impressed near the tip.

1. **M. linearis**, n. sp.

Very elongate, cylindrical, piceous or brown, shining, glabrous; head and beak finely punctured. Prothorax more than one-half longer than wide, more strongly but not densely punctured, without impressions; slightly narrowed in front, sides rounded near the base. Elytra not wider than prothorax, striæ composed of approximate punctures, deeply exarate on the posterior declivity for a short distance. Beneath distinctly but finely punctured; flanks of prothorax feebly concave in front. Antennæ and legs reddish brown. Length 3 mm.; .12 inch.

Haulover; Florida, March: Messrs. Hubbard and Schwarz; abundant on the sea shore; no sexual differences observed. The fifth ventral segment is longer than the third and fourth united; the three together are scarcely longer than the first and second; the first ventral suture is obliterated, even at the sides.

ALLOMIMUS n. g.

I cannot refer *Cossonus dubius* Horn, l. c. 442, to any of the genera described by Wollaston. It is nearly allied to *Macrancyclus*, but is of less elongate form, and very much more coarsely sculptured; the elytra are in fact rather sulcate than striate, though the deep striæ are coarsely punctured, and the interspaces narrow with single rows of small punctures. The beak is stout, cylindrical, a little narrower than the head, and nearly as long as the prothorax; the antennal grooves commence in front of the middle, and run directly towards the eyes, which are small, rounded, moderately convex and not very finely granulated; the antennæ are not very stout, the scape straight, strongly clavate, extending to the front margin of the eyes; funicle 7-jointed, first joint a little larger and stouter, remaining joints short, closely united, gradually but slightly broader, club large, oval-pointed, pubescent, annulated. Scutellum distinct. Front coxæ widely separated; thighs rather stout, tibiæ dilated, with a small spine at the inner angle; terminal hook long; tarsi with the third joint a little wider, and feebly bilobed; last joint long, with divergent claws.

1. **A. dubius** Horn, l. c. 442 (*Cossonus*).

I have seen but one specimen from Illinois; it is easily known by the characters given above, and by the very coarse sculpture. Length 1.75 mm.: .07 inch.

STENOMIMUS Woll.

I think that *Phlœophagus pallidus* Boh., Sch. Curc. viii, 2d, 279; *Cossonus pall.* Horn. Proc. Am. Phil. Soc. 1873, 441, may properly be referred to this

Digitized by Google

genus, the characters of which are set forth by Wollaston, Trans. Ent. Soc. London, 1873, 480. It is easily recognized by the pale color, very small size and narrow form. Southern States.

CAULOPHILUS Woll.

1. **C. latinasus.** *Rhyncolus lat.* Say, Curc. 30, ed. Lec. i, 299; Boh., Sch. Curc. iv, 1068; *Cossonus pinguis* Horn, Pr. Am. Phil. Soc. 1873, 442.

Southern States: the synonymy is on the authority of Dr. Horn, from specimens in the collection of Mr. Chevrolat. The reference to the genus is made after a careful study of the characters given by Wollaston, Ins. Maderensia, 315, pl. vi, f. 4; Trans. Ent. Soc. London, series 2d, v, 368, supplemented by the descriptions in the same work, 1873, 499 and 586. Except that the punctuation of the prothorax is coarser in the figure than in the three specimens in my collection, I should not venture to declare them as a different species from *C. sculpturatus.*

MESITES Sch.

1. **M. subcylindricus** (Horn), Pr. Am. Phil. Soc. 1873, 441, (*Cossonus*).

One ♂ found by me on the sea shore near Cape Henlopen, Delaware. This is the largest *Cossonide* known in our fauna, being 6.5 mm.; .26 inch long.

Tribe III. RHYNCOLINI.

The genera of this tribe while differing from those of the *Cossonini* only by having the prosternum very narrow between the coxæ, and by having a deep transverse gular groove beneath in front of the eyes, exhibit other characters which show a strong approximation to the *Scolytidæ;* thus the number of joints in the funicle of the antennæ varies so as to be barely of generic value; the beak becomes very much shortened, and the head comparatively larger, as in *Stenoscelis;* the form of the club varies, becoming wedge shaped, truncate and spongy at tip in *Wollastonia,* thus recalling the form seen in *Rhynchophorus,* &c.; quite rounded or perhaps a little transverse in *Stenoscelis.* The form is also that of certain *Scolytidæ. Rhyncolus* resembles closely one section of *Hylastes,* while *Stenoscelis* has altogether the appearance of *Hylurgops* (*H. rugipennis,* &c.).

As in the Rhynchophora, from the nearly perfect representation of past and present forms, there are almost always intermediate genera to be found, I would say that *Phlœophagus* seems to be one of such intermediates, and would be in place in the preceding tribe, if I did not regard the approximate front coxæ as having greater systematic value than the longer beak and the weaker gular groove.

The antennal grooves always commence near the tip of the beak and descend obliquely below the eyes.

Our genera may be separated as follows:

Digitized by Google

Beak thick, neither dilated at tip, nor cylindrical, slightly narrowed from the base to the tip, convex	2.
Beak very short, parallel on the sides.......	4.
" longer, gula only feebly concave transversely..........................	PHLŒOPHAGUS.
2. Club rounded, pubescent, feebly annulated	3.
Club corneous, truncate at tip, which is spongy; funicle 5-jointed................	WOLLASTONIA.
3. Funicle 5-jointed...........................	AMAURORHINUS.
" 6-jointed...........................	HEXARTHRUM.
" 7-jointed	ELASSOPTES.
4. Tarsi dilated, antennal grooves long........	RHYNCOLUS.
" narrow, antennal grooves very short..	STENOSCELIS.

The genera and species are fully described by Dr. Horn in the memoir above cited, and need no farther mention at present.

Family IX. SCOLYTIDÆ.

Mentum moderate in size, varying in form in some genera according to sex; without gular peduncle (except in *Hylastes*, where it is very small); ligula and palpi small, the former sometimes retracted, sometimes prominent.

Maxillæ exposed, palpi stout and short.

Mandibles stout, curved, more or less toothed on the inner side.

Antennæ inserted on the sides of the head, between the eyes and mandibles; composed mostly of scape and club, funicle usually very short, from 1- to 7-jointed; club large, solid, annulated, or rarely (*Phlæotribus*) lamellated; surface of the club more or less sensitive according to genus.

Head prominent in some tribes, deflexed and protected by the prothorax in others; eyes usually large and transverse; beak never long, frequently so short as to be not apparent. Labrum feebly developed, sometimes visible.

Prothorax truncate in front, exposing the head, (*Platypodidæ, Scolytini* and *Hylurgini*), or prominent, convex and rounded (most *Tomicini*); lateral edge not distinct,* and prosternal sutures obliterated; flanks excavated for the partial reception of the front legs in *Platypodidæ*; coxal cavities usually confluent; separated in a few genera.

Mesosternum triangular, pointed behind, or slightly truncate, episterna (*Platypodidæ*) excessively large, ascending between the base of the prothorax and elytra with the epimera small, posterior and transverse, or with the suture very indistinct; coxæ rounded, not widely separated.

Metasternum long, sometimes, (*Platypodidæ*) very long; side pieces parallel, or nearly so, not dilated in front.

Legs moderate in length, rather stout, front coxæ almost always con-

*Except in *Scolytus*. *Eutomus*, as has been elsewhere observed is not a Rhynchophorous insect but allied to *Rhipidandrus*.

Digitized by Google

tiguous; middle and hind coxæ more or less separated; tibiæ compressed, toothed or with transverse ridges on the outer side; armed with a terminal hook at the inner apical angle. Tarsi in some genera filiform and 5-jointed; in others 4-jointed, with the third joint either narrow, or dilated and bilobed; last joint long, with large, simple, divergent claws.

The insects of this family are mostly of cylindrical form, and small size. They are the most formidable enemies of trees, sometimes devastating the forests, especially of conifers, by appearing in incredible numbers: the burrows are chiefly between the wood and the bark, though some genera penetrate more deeply (*Xyloteres, &c*). The patterns made by them are complex and vary according to genus and species; those of several European species are figured in the excellent work of Ratzeburg,* and since descriptions of our species are now accessible, so that their identification is easy, I trust that those interested in the preservation of our forest trees may direct their attention to this important subject. Specimens of the ravages of these insects should be carefully collected, with individuals taken from the burrows, and these should be deposited in some museum where they will be carefully preserved for future study.

Since the publication of my revision of this family,† a few additional species have been found, and a renewed study of the genera has rendered necessary some modification of the classification there proposed.

The great differences exhibited by *Platypus*, and its allies, indicate the propriety of separating them as a distinct sub-family, a course already adopted by Lacordaire.

First joint of tarsi as long as the others united.... **PLATYPODIDÆ.**
" " " much shorter than the others united.. **SCOLYTIDÆ.**

Sub-family I. PLATYPODIDÆ.

Head large, not covered by the prothorax, front wide, oblique or vertical; labrum small, but distinct. Beak wanting; eyes rounded, not convex, finely granulated in our species. Antennæ with large scape (elongated and curved in some foreign genera), and large compressed solid club, which is pubescent except for a small space at the base; funicle composed of four small joints. Prothorax elongate, truncate before and bisinuate behind; subsinuate on the sides; flanks broadly excavated for reception of front legs. Prosternum moderately long in front in the coxæ, which are very large, conical, exserted and contiguous in our species; space behind the coxæ very short. Pronotum considerably longer than the under surface; middle of base notched for reception of the carina of the mesonotum. Mesosternum triangular, middle coxæ narrowly separated; episterna very large, quadrate, occupying the space formed by the prolongation of the pronotum; epi-

*Die Forst-Insecten, Vol. I.

†Synopsis of the *Scolytidæ* of America, north of Mexico, by C. Zimmermann, M.D., with notes and additions by J. L. LeConte, M.D. Trans. Am. Ent. Soc. 1868, 141.

Digitized by Google

mera small, transverse, posterior and indistinct. Metasternum very long, episterna parallel, rather wide; hind coxæ slightly separated. Ventral segments 5; first and second very short, together scarcely equal to the third, which is equal to the fourth; fifth a little longer, rounded behind; last dorsal segment horizontal, partially or completely covered by the elytra, according as the segments are deflexed or retracted.

Elytra margined and perpendicularly declivous at base, striate, variously prolonged into processes at tip, according to species and sex. Mesonotum strongly carinate.

Legs short, thighs stout, compressed; tibiæ shorter than the thighs, stout, unguiculate, marked on the outer side with transverse ridges. Tarsi long, slender, first joint as long or longer than the three following united; fourth joint one-half as long as the third; fifth as long as the joints 2–4 united; claws long, simple, divergent.

This sub-family is represented in our fauna by a few species of *Platypus* found chiefly in the Southern States. The species are cylindrical, and suggest a resemblance to certain *Colydiidæ*, from which, however, they widely depart in structural characters.

PLATYPUS Herbst.

In this genus the maxillary palpi are large, flat, membranous, 4-jointed, with the joints received one into the other, and the pygidium is almost or entirely covered by the elytra. The sexual differences in the processes of the elytra are such as to make it difficult to construct a table of the species:

1. Ventral segments with elevations..........	2.
" " without elevations........	3.
2. Elevations at the posterior margin of the third segment......................	1. **flavicornis** ♀.
Elevations very acute, at the posterior margin of the fourth segment.............	2. **quadridentatus** ♀.
3. Prothorax nearly twice as long as wide....	3. **compositus** ♂ ♀.
" one-half longer than wide........	4. **rugulosus** ♂ ♀.
" with two large discoidal punctures	1. **flavicornis** ♂.

1. **P. flavicornis** Chap., Mon. Plat. 154, f. 70, ♂ ♀: *Bostrichus flav.* Fabr., Mant. 212; Sp. Ins. i, 67; Ent. Syst. ii, 364; Syst. El. ii, 384; Herbst, Käfer, v, 118; *Scolytus flav.* Oliv., Ent. 78, 4, pl. 1, f. 1.

♂. Elytra with the third interspace somewhat elevated and roughened at base; the posterior process of the elytra shorter and less acute; the declivity of the elytra concave near the tip, and the tip itself truncate and feebly emarginate. Ventral segments finely rugose, regularly convex; prothorax with a large puncture each side of the anterior extremity of the short dorsal impressed line; *P. disciporus* Chap., l. c. 219, f. 123, is a variety in which the elytral process is shorter and less prominent.

♀. Elytra with the base of the third interspace less elevated; the posterior process longer, more acute, serrate on the outer side. Ventral surface

Digitized by Google

punctured and finely rugose, opaque; posterior margin of third and fourth segments thickened, the former with two distant conical elevations.

South Carolina, Florida and Texas, extending into Mexico. Length 5.2–5.7 mm.; .21–.23 inch.

2. **P. quadridentatus.** *Scolytus quadr.* Oliv., 78.5; pl. 1, f. 3: Lec. apud Chapuis, Mon. Plat. 338, (err. cler.): *P. Blanchardi* Chap., Mon. 185, f. 96.

♀. Elytra deeply striate, with a posterior process at the end of the third interspace, and a large compressed obtusely truncate one at the junction of the fifth and eighth interspaces: ventral surface opaque, densely punctured; fourth segment with two acute spines near the hind margin.

♂. Unknown.

Florida: length 4 mm.; .16 inch; occurs also in Texas, according to Mr. Chapuis, if I am correct in considering his species as the same.

3. **P. compositus** Say, Journ. Ac. Nat. Sc. Phila., iii, 324 (♀); ed. Lec. ii, 182; Er., Wiegm. Arch. 1836, ii, 65; Chapuis, Mon. Plat. 163, f. 75, ♂. ♀; *P. parallelus* Chap., ibid. 164, f. 76, ♂, ♀; ? *Bostrichus par.* Fabr., Syst. El. ii, 384, (description of no value); ?. *P. tremiferus* Chap., Mon. Plat. 174, f. 85, ♂, ♀; ? *P. perfossus* Chap., ibid. 176, f. 86, ♂, ♀; ? *P. rugosus* Chap., ibid. 176, f. 87, ♂, ♀.

♂. Apical part of front smooth; prothorax scarcely punctulate; elytra transversely impressed near the tip, without posterior process. Ventral segments shining, sparsely punctulate.

♀. Front uniformly rugose; prothorax distinctly punctulate; elytra with the second interspace compressed and forming an acute cusp near the tip; fifth and ninth interspace prolonged into a large process, which is concave above, and tridentate at tip; the outer tooth much longer, narrow and truncate or emarginate at tip according to age of specimen, or direction of view. Ventral segments opaque, densely punctured; fifth flat, not carinate, nor tuberculate.

Illinois to Texas, Louisiana, Florida, South Carolina. Neither the figures nor descriptions of Dr. Chapuis indicate anything more, in my opinion, than slight individual variations of form and sculpture, such as I would be unwilling to admit as having specific value. Nevertheless, as I have not seen the typical specimens, I cannot be certain of the correctness of this view. The original description of Fabricius refers to a male of this or some allied species, but is quite irrecognizable, and should not take precedence over the well-defined characters published by Say. Length 4 mm.; .16 inch.

4. **P. rugulosus** Chap., Mon. Plat. 192, f. 103, ♂, ♀.

♂. Front entirely opaque, finely rugose; prothorax feebly punctulate; elytra finely not deeply striate, transversely impressed at tip, without subapical process. Ventral segments shining, sparsely and finely punctured.

♀. Front entirely opaque, densely rugosely punctured (areolate in fact); prothorax unequally punctulate and punctured, less finely at the sides; ely-

Digitized by Google

tra deeply striatopunctate, interspaces more convex behind; second elevated, forming a small cusp at the posterior declivity; posterior process as in the preceding, but shorter and stouter, with the three teeth of nearly equal length, the outer one broad, and not very distinctly separated from the upper one; the inferior one a little shorter and acute. Ventral segments opaque, densely punctured; fifth sometimes finely carinate, sometimes feebly tuberculate.

Cape San Lucas, Lower California; Mr. Xantus; also found in Mexico. This species is allied to the preceding, but is less elongate, the prothorax being but little longer than wide, and the deep impressed dorsal line is longer, and not terminated in front by a short, transverse impression. The sexual characters, as will be seen, are quite different.

5. **P. punctulatus** Chap., Mon. Plat. 199, f. 110, ♀.

Texas, allied to the preceding, and apparently differs only by the last ventral segment having a strongly marked tubercle. Unknown to me.

Sub-family II. SCOLYTIDÆ (*genuini*).

The characters by which this sub-family differs from the *Platypodidæ* have been already sufficiently pointed out; in other respects the species differ greatly according to genus and tribe, and the chief peculiarities will be pointed out under the appropriate heads.

The genera which occurs in our fauna indicate the following tribes:

1.	Prothorax not prolonged over the head, which is oblong and prominent; tarsi with fourth joint smaller or indistinct; third joint usually bilobed..............	2.
	Prothorax prolonged over the head, which is deeply immersed and globose; tarsi filiform, 5 jointed........	TOMICINI.
2.	Ventral surface ascending obliquely,..................	SCOLYTINI.
	" " regularly cylindrical..................	HYLESINI.

Tribe I. TOMICINI.

Although the genera of this tribe are the farthest removed from *Cossonidæ* by their characters; they are in some respects the most nearly allied to *Platypus*, with which the family must naturally commence, on account of the relations between the latter and *Brenthidæ*.

The head is globose, or nearly so, and deeply immersed in the prothorax; the eyes are transverse, sometimes divided, (*Xyloterus*); the front is not prolonged into a beak; the antennæ are inserted near the base of the mandibles; the scape is long and stout, the funicle short, composed of from one to five joints, the mass large, compressed, varying in form and structure according to genus. Prothorax more or less cylindrical behind, prolonged in front over the head and much rounded, so that the anterior opening becomes very oblique, or even sometimes, almost horizontal; the sculpture is peculiar, and consists for a greater or less distance from the apex of sharp granules, or little spines; behind, the surface is smooth or punctured; the

Digitized by Google

side margin is not distinct.* The mesonotum is never carinate as in *Platypus*. Elytra suddenly declivous in front, so that the edge fits against the base of the pronotum; usually obliquely excavated and toothed on the posterior declivity; ridge on inner surface near the outer margin, effaced near the tip; groove very deep and narrow. Pygidium entirely covered. Mesosternum acute behind, side pieces obliquely divided, epimera small, not attaining the coxæ, Metasternum rather long, side pieces narrow. Ventral segments five; first and second longer, closely united; fifth longer than the fourth, rounded behind, edge acute, fitting under the elytral edge. Front coxæ large, globose, prominent and contiguous; middle coxæ nearly contiguous; hind coxæ also.

Legs stout, thighs thick, not toothed; tibiæ compressed, armed with a large hook at the inner angle of the apex; outer edge serrate and acute; rarely flattened, with two edges, between which are transverse ridges, somewhat as in *Platypus*. Tarsi slender; fourth joint very small, but distinct; fifth joint long, with large, divergent simple claws.

Crypturgus and *Dolurgus* seems to me more properly placed in the tribe *Hylurgini*. The other genera represented in our fauna arrange themselves naturally into groups, according to the structure of the club of the antennæ.

Club large, oval, compressed. pubescent and transversely annulated on both sides, sutures straight or slightly curved; inner face usually broadly concave; tibiæ serrate....... **Corthyli.**

Club large, oval, solid, pubescent on both sides; eyes completely divided; tibiæ serrate......................... **Xyloteri.**

Club small, entirely corneous on the inner face, obliquely truncate on the outer face; truncature spongy and sensitive, marked with two concentric lines, or transverse sutures, or entirely terminal and narrow; tibiæ serrate.... **Xylebori.**

Club large, oval or rounded, compressed, entirely corneous on the inner face, more or less pubescent on the outer face, and divided by two or three sutures, which are usually sinuated or angulated; declivity of elytra deeply concave with acute margin, usually strongly toothed; funicle of antennæ with five distinct joints; tibiæ coarsely serrate.. **Tomici.**

Club elongate-oval, marked on each side by sutures which are sometimes long and curved, but sometimes nearly straight; the basal joint corneous, others pubescent; funicle 5-jointed; elytra convex behind, with the suture slightly prolonged; tibiæ fringed with hair, but not serrate; tarsi usually with joints 1–3 rather stout, fourth very small, fifth long and slender.................... **Micracides.**

*One at least of the groups (*Eutomides*), mentioned by Lacordaire, having the flanks separate from the pronotum, must be excluded from this family; it is allied to *Rhipidandrus* Lec., which I placed in *Tenebrionidæ*. Its position and affinities are still doubtful. Vide Chapuis, Mem. Soc. Roy, Liége, 1869, 6; Horn, Trans. Ent, Soc. 1875, 151.

Digitized by Google

Group I. **Corthyli.**

In this group the species are mostly of very small size, and are easily recognized by the club of the antennæ, which is pubescent and annulated with nearly straight sutures on both sides. One species of *Micracis* (*hirtellus*), as will be seen below, has a nearly similar club, and shows thereby a resemblance to the present group, but is otherwise so closely allied to the other *Micracis* that I have not been disposed to separate it from them. The funicle varies from one to five joints; the tibiæ are serrate or ridged transversely on the outer side; the tarsi are slender, the fourth joint distinct; fifth long, with simple, divergent claws. The anal segment of the ♂ is occasionally visible from beneath.

The genera may be thus separated:

1.	Funicle 1-jointed..........................	2.
	" 2–5-jointed........................	3.
2.	Body robust..............................	CORTHYLUS.
	Body slender..............................	MONARTHRUM.
3.	Outer part of funicle rather slender..........	PITYOPHTHORUS.
	" " " very short.............	HYPOTHENEMUS.

CORTHYLUS Er.

The body is much more robust than in *Monarthrum*, and the upper surface is strongly punctured. The club of the antennæ, connected with the 1-jointed funicle by a short slender peduncle, is much larger, opaque, finely pubescent, not fringed. The front tibiæ are flattened and margined on the outer face, but there are no transverse ridges as in *Monarthrum*, and only three acute teeth on the anterior edge near the tip; the tarsi are less slender, the 1st joint is a little shorter than the 2d; the 2d and 3d are equal, the 4th small, 5th as long as the 2d and 3d united, slender, claws divergent, simple, ventral segments subequal, 5th not longer than 4th, truncate; pygidium convex, partly inflexed, distinctly visible from beneath; 1st ventral suture deeply impressed.

The pronotum is marked with a fine lateral line near the hind angles, and along the base; the prosternum is extremely short in front of the coxæ. Neither of these characters occurs in *Monarthrum fasciatum*, but the first of them exists in the other species which I have referred to that genus.

1. **C. punctatissimus.** *Crypturgus punct.* Zimm., Trans. Am. Ent. Soc. 1868, 144.

♂. Head flattened, opaque, slightly and broadly concave at the middle.

♀. Head slightly convex, shining, punctured.

Middle, Southern and Western States; rare. Length 4 mm.; .15 inch.

MONARTHRUM Kirsch.

In this genus the body is elongate and cylindrical; the scape of the antennæ is long and slender, the funicle of but one short joint, the others being absorbed in the club, which is rounded, very much compressed, with two

Digitized by Google

deep straight transverse sutures, fringed at the end with very long ciliæ or bristles in the ♂, or even (*mali*) furnished with a long spine; eyes slightly emarginate. Prothorax much longer than wide, disc finely asperate in front, alutaceous behind; anterior opening oblique. Elytra elongate, nearly perpendicularly declivous behind, and pubescent on the declivity; feebly punctured in rows. Front tibiæ flattened on the outer side, with two distinct edges, between which are transverse ridges; tarsi long and slender; first joints longer; 2–3 equal, fourth small, fifth as long as second and third united. Ventral segments first and second longer; third, fourth, and fifth short, equal, the last broadly rounded at tip, nearly truncate. Anal segment present in both sexes, perpendicularly declivous, small, triangular, with rounded angles.

A. Club of antennæ of ♂ fringed at the tip with long hairs; CORTHYLOMINUS Ferrari..............
  Posterior declivity of elytra hairy; elytra yellow, with the posterior third black.............. ... **1. fasciatum.**
B. Club of antennæ of ♂ with a long acute spine, and a few hairs; COSMOCORYNUS Ferrari.
  Larger, piceous, elytra brownish at base, pubescent at tip.................................... **2. scutellare.**
  Smaller, brown, prothorax testaceous behind, elytra not hairy at tip.............................. **3. dentigerum.**
  Smaller, brown; elytra not hairy at tip, suture deeply impressed on posterior declivity....... **4. mali.**

1. **M. fasciatum.** *Bostrichus fasc.* Say, Journ. Ac. Nat. Sc. Phila. v, 255; ed. Lec. ii, 318; *Crypturgus fasc.* Zimm., Trans. Am. Ent. Soc. 1868, 143; *Corthylominus fasc.* Ferrari, Tomicides, 48; *Pterocyclon simile* Eichhoff, Berl. Ent. Zeitschr. 1868, 277.

♂. Club of antennæ fringed with very long hairs; posterior declivity of the elytra slightly concave near the suture, with one small tubercle towards the upper part; feebly margined near the tip,

♀. Club of antennæ with only a few shorter marginal hairs; declivity of elytra more strongly margined near the tip; the tubercle is replaced by a long elevation, parallel with the suture, slightly cuspidate in front.

Lake Superior to Florida. Length 2.4 mm.; .10 inch. The head is large, flat and opaque in both sexes, but is slightly impressed in the ♀.

2. **M. scutellare.** *Corthylus scut.* Lec., Pac. R. R. Expl. and Surveys, Insects, 49 (♂); *Corthylomimus scut.* Ferrari, Tom. 49; *Cryphalus cavus* Lec., Trans. Am. Ent. Soc. 1868, 153, (♀).

♂. Club of antennæ with a few long hairs at the tip; armed with a long porrect spine on the outer margin; declivity of the elytra flat, margined near the tip, with three small denticles each side near the suture, and along the upper part; also two others on the face of the declivity, which is slightly hairy. Head flat, fringed with hairs.

♀. Club of antennæ oval-rounded without apical spine; declivity of ely-

Digitized by Google

tra deeply concave, slightly hairy, bounded by a sharp edge, from the tip for nearly two-thirds its length; this edge terminates in a cusp at the anterior end; the three small denticles at the upper margin of the declivity are much stronger than in the ♂. Head slightly convex, not fringed with hairs, coarsely punctured, finely rugose and opaque near the tip.

California; San Jose and Fort Tejon. Length 3.5 mm.; .14 inch.

3. **M. dentigerum.** *Cryphalus dentiger* Lec., Trans. Am. Ent. Soc. 1868, 154.

♀. Club of antennæ not fringed; declivity of elytra retuse at the side, deeply concave towards the suture, with an acute cusp in the concavity each side, about equidistant from the suture and the apex, which is acutely and strongly margined. Head flat, opaque. ♂ unknown.

One ♀, Middle California, given me by Dr. Horn. The posterior half of the prothorax, the antennæ and legs are yellow-testaceous; the rest of the body is blackish brown. Length 2 mm.; .08 inch.

4. **M. mali.** *Tomicus mali* Fitch, N. York Reports on noxious Insects, iii, p. 8, No. 5; Zimm., Trans. Am Ent. Soc. 1868, 143; *Pterocyclon longulum* Eichoff, Berl. Ent. Zeitschr. 1868. 278.

♂. Club of antennæ with a long apical spine, and a few hairs; declivity of elytra oblique, not retuse at the sides, acutely margined only at the apex, and for a short distance behind; face of declivity with a slight reniform elevation rising into two cusps near the suture, which is deeply impressed and excavated at that place: head flat, opaque, not fringed with hairs.

♀. Club of antennæ without apical spine; declivity of elytra as in ♂, but with the reniform elevation and its two cusps much stronger; head slightly convex, sub-opaque, feebly punctured.

Lake Superior to Florida; depredates on apple trees. Length 2 mm.; .08 inch. By a typographical error I cited Dr. Fitch's Second Report for this species.

PITYOPHTHORUS Eichhoff.

Under this name I would associate most of the species which I formerly called *Cryphalus*, but which differ from *Cryphalus tiliæ* by having the sutures of the antennal club transverse, nearly straight and visible on both sides, instead of strongly curved, as in that species. The funicle of the antennæ consists of two parts; the first joint rather large, as usual, and about as wide as long; the remainder is narrow at base, gradually becoming broader, and forming a stem to the club; this stem is divided by three transverse sutures which are frequently very indistinct, and I consider their number as having little value.

The front tibiæ are compressed, with one acute outer edge, but no flattened space as in *Monarthrum*; this edge is very feebly serrate; the joints 1–3 of the tarsi are subequal and rather stout, the fourth is small; fifth about as long as the others united; claws large, divergent.

A. Club of antennæ nearly smooth on the outer surface, and indistinctly annulated, sparsely fringed with long hairs; upper surface pubescent, su-

Digitized by Google

tures deep, slightly curved. Hairs of the body slender, not verticellate nor serrate; elytra feebly punctured; prothorax asperate in front, nearly smooth behind. Fifth ventral segment broadly rounded behind, pygidium but slightly visible from beneath; GNATHOTRICHUS Eichhoff.

1. Posterior declivity of elytra not retuse	**2.**
" " " retuse, concave near the suture	**1. retusus.**
2. Prothorax moderately rough in front...............	**2. materiarius.**
" very rough in front, size much smaller..	**3. asperulus.**

1. **P. retusus.** *Cryphalus ret.* Lec., Trans. Am. Ent. Soc. 1868, 155, (♀); *C. sulcatus* Lec., ibid. 155, ♂.

♂. Front finely and convergently striate; posterior callosity of the elytra less prominent.

♀. Head shining, sparsely and strongly punctured; posterior callosity of elytra more prominent.

California, Oregon and Vancouver Island. Length 3.5 mm.; .14 inch.

2. **P. materiarius.** *Tomicus mat.* Fitch, N. York Reports on noxious Insects, iv, p. 41, No. 246; *Crypturgus mat.* Zimm., Trans. Am. Ent. Soc. 1868, 143; *Gnathotrichus corthyloides* Eichhoff, Berl. Ent. Zeitschr. 1868, 275.

♀. Head shining, sparsely but strongly punctured.

♂. Unknown to me.

Canada to Texas. Length 2.5 mm.; .10 inch. Infests pine timber. The galleries as figured by Dr. Fitch, are remarkable for the branches being short, parallel, and at right angles to the main gallery. He also observes, what is probably true of all the species which mine into the wood, instead of simply under the bark, that the females are vastly more numerous than the males.

3. **P. asperulus.** *Cryphalus asp.* Lec., Trans. Am. Ent. Soc, 1868, 155.

Virginia, Mr. E. T. Cresson; one female; the head is retracted, but so far as I can see seems to be flat, and punctured as in the preceding. Length 1.5 mm.; .06 inch.

B. Club of antennæ distinctly annulated and pubescent on both sides, not fringed with long hair. Hairs of the body stout or slender, not verticellate nor serrate. Prothorax asperate in front, finely punctulate behind. Elytra punctulate and pubescent. Front tibiæ moderately serrate, front tarsi with joints 1–3 stout; fifth longer than the others united. Pygidium scarcely visible from beneath.

Elytra scarcely punctulate; hairs stout, short......	**4. minutissimus.**
Elytra finely punctulate; hairs longer, and short, intermixed..	**5. pubipennis.**
Brown, shining, more slender, more strongly punctulate, hairs sparse, fine........................	**6. pilosulus.**

Digitized by Google

4. **P. minutissimus.** *Tomicus pusillus* ‖ Harris, Trans. Nat. Hist. Soc. Hartford, 83; *Crypturgus* ‡ *min.* Zimm., Trans. Am. Ent. Soc. 1868, 143 (nec Fitch, N. York Reports on noxious Ins. iv. No. 245).

♂. Head deeply concave, edges of concavity fringed with long, yellow, silky hairs.

♀. Head punctured, slightly hairy.

Middle and Southern States. Length 1.8 mm.; .07 inch. If the name *T. pusillus* ‖ is to be cited under any species it must be for this, which agrees very well with the description of Dr. Harris, That mentioned by Dr. Fitch is quite different, and is closely allied to *P. ramulorum* Perris, which is considered by Eichhoff as the same with *typographus* Ratz.

5. **P. pubipennis.** *Tomicus pub.* Lec., Pac. R.R. Expl. and Surv. Ins. 59; *Cryphalus pub.* Lec., Trans. Am. Ent. Soc. 1868, 156.

♂. Head deeply concave; edge of the concavity fringed with long silky hairs.

♀. Head shining, sparsely hairy, punctured with an interocular tubercle.

San Jose, California; the longer hairs of the elytra are arranged in rows.

6. **P. pilosulus.** *Cryphalus pil.* Lec., Trans. Am. Ent. Soc. 1868, 156.

♂ ?

♀. Front flat, opaque, with a finely impressed median line.

Middle California. I have but two specimens, and in one the head is retracted upwards so that no part of the upper surface is visible. Length 2 mm.; .08 inch.

C. Club of antennæ distinctly annulated and pubescent on both sides, not fringed with long hair. Hairs of body slender, verticellate and serrate, especially on the head and prothorax. Prothorax asperate in front, punctured behind. Elytra punctured, sparsely pubescent. Front tibiæ finely or feebly serrate in most species.

1. Pygidium strongly inflexed, causing the fifth ventral segment to appear broadly emarginate.........	2.
Pygidium but slightly visible from beneath, fifth ventral broadly rounded or subtruncate...............	4.
2. Elytra retuse behind, without cusps; eyes emarginate....................................	3.
Elytra retuse behind, each with two cusps; eyes not emarginate....................................	7. **carinulatus.**
Elytra with coarse punctures arranged somewhat in rows....................................	8. **pullus.**
Smaller and stouter, elytra with large punctures not arranged in rows..........................	9. **pulicarius.**
4. Elytra retuse behind. and concave along the suture.	5.
" not retuse on posterior declivity.......	7.

Digitized by Google

5. Elytra strongly punctured in approximate rows.....	**6.**
" strongly and confusedly punctured.........	**10. carinicepe.**
Elytra finely and confusedly punctured	**11. fossifrons.**
6. Larger and stouter, rows of punctures confused towards the suture..........................	**12. confinis.**
Smaller and more slender, rows regular approximate	**13. nitidulus.**
Much smaller, rows more distant, asperities of prothorax not concentric......................	**14. puncticollis.**
Much smaller, rows stronger, asperities of prothorax concentric..................................	**15. lautus.**
7. Elytra punctured in rows.........................	**8.**
" confusedly punctured, hairs erect............	**16. puberulus.**
8. Rows of punctures irregular, approximate..........	**17. digestus**
" " fine and distant; prothorax with an oval patch of dense hair each side..........	**18. comatus.**

7. P. **carinulatus.** *Cryphalus car.* Lec., Trans. Am. Ent. Soc. 1874, 70. California, extending as far South as the Mojave region. The pubescence is long and erect, and the eyes are not emarginate. The dorsal line of the prothorax is narrow, smooth and distinctly elevated. Length 2–3 mm.; .08–.12 inch.

♂. Seven specimens agree in having the head dull, densely punctured, with a very large and deep excavation; the general surface of the head is thinly clothed with erect pubescence, but the anterior margin of the front, above the mandibles, is fringed with long, yellow prostrate hair.

♀ ?. One specimen differs in having the head more convex, less densely punctured, the excavation much smaller and less deep, with a distinct longitudinal elevation at the middle. The cusps of the declivity of the elytra are less prominent, and I am therefore in doubt if it should be referred to this species.

8. P. **pullus.** *Crypturgus‡pullus* Zimm., Trans. Am. Ent. Soc. 1868, 143; ? *P. bisulcatus* Eichhoff, Berl. Ent. Zeitschr. 1868, 274.

♂. Head strongly punctured, rather flat, broadly but slightly concave in front.

♀. Head strongly punctured, uniformly convex, with a slight callus on the front.

Middle States. The declivity of the elytra is almost without cusps, and is slightly more retuse in the ♀ than in the ♂, but the suture is strongly elevated in both. Length 2.3 mm.; .09 inch.

P. pulchellus Eichhoff, l. c. 275, seems to be closely allied to this species, and to differ chiefly by the prothorax strongly, rugosely punctured behind, and the suture less elevated. If the locality be California, then it may possibly be *P. puncticollis*, but until the species of this author are described with some reference to allied species, or synoptic tables prepared, they cannot be satisfactorily identified.

Digitized by Google

9. **P. pulicarius.** *Crypturgus‡pul.* Zimm., Trans. Am. Ent. Soc. 1868, 144.

Illinois, South Carolina and Florida; four specimens, in which there is no sexual difference; the head is punctured and convex, with a very small frontal callus. The form is stouter, the size much smaller, and the punctures coarser than in our allied species; the pubescence is sparse, long and erect. Length 1.5 mm.; .06 inch.

10. **P. cariniceps,** n. sp.

Rather slender, cylindrical, blackish piceous shining, pubescence fine, sparse and erect. Head (♂) finely punctured, opaque, with two very deep excavations, extending almost to the front margin, and separated by a narrow, elevated, longitudinal carina; eyes deeply and narrowly emarginate. Prothorax longer than wide, anterior half densely asperate, separated from the posterior half by a shallow, transverse impression; posterior half shining, distinctly but not densely punctured, smooth dorsal line not elevated, base distinctly margined. Elytra strongly punctured, punctures arranged partly in rows; declivity strongly retuse, with a few little asperities on the highest part of the elevation; suture slightly impressed, and marked with a row of punctures as far as the declivity, where it becomes smooth and deeply impressed, concavity smooth, broader at the tip. Pygidium scarcely visible from beneath; fifth ventral not longer than fourth, broadly rounded behind. Antennæ and legs yellow-brown; club transversely annulated with curved sutures; outer part of funicle indistinctly divided into four parts; tibiæ with two or three feeble teeth towards the tip. Length 2.5 mm.; .10 inch.

Detroit, Michigan; Messrs. Hubbard and Schwarz; one ♂. The pubescence has probably been partly abraded. The peculiar sculpture of the head induces me to believe that the reference of the supposed ♀ under *P. carinulatus* may be erroneous, and that it probably indicates a distinct species, which, however, cannot be correctly defined from want of sufficient material.

11. **P. fossifrons,** n. sp.

Of the same form and color as the last, but the head (♂) has one round and very deep fovea, and the eyes are not emarginate. Prothorax longer than wide, asperate on the front half, strongly and deeply punctured behind; smooth dorsal line narrow, distinctly elevated towards the middle of the disc. Elytra rather finely and not regularly punctured; pubescence long, erect; sutural stria visible, deeply excavated behind; declivity slightly retuse, with two indistinct cusps. Antennæ and legs yellow-brown, of the same form as in the last. Length 2.3 mm.; .09 inch.

Vancouver Island; Messrs. Matthews; two ♂ specimens. This species resembles *P. carinulatus* in sculpture, and in the form of the eyes; but the excavation of the head is smaller, deeper and more pit-like; the posterior callosity of the elytra is less prominent; the cusps are small and feebly developed, and finally the pygidium is much less inflexed, so as to be hardly visible from beneath.

Digitized by Google

12. **P. confinis**, n. sp.

Rather slender, piceous black, shining, (nearly glabrous ?). Eyes deeply emarginate. Prothorax a little longer than wide, strongly asperate over a circular space extending from the middle to the tip, coarsely punctured on the rest of the surface; smooth dorsal line not elevated, obsolete in some specimens; base finely margined. Elytra strongly punctured; punctures here and there arranged in approximate rows, but confused towards the suture; declivity retuse, but without cusps, concavity smooth, sutural stria deeply excavated behind. Antennæ and legs brown, of the same form as in those above described. Pygidium, except when protruded, but slightly visible from beneath; fifth ventral not longer than fourth, and not emarginate. Length 2.5 mm.; .10 inch.

♂. Head clothed with long yellow hair.

♀. Head nearly glabrous, shining, punctured, with a large, obtuse elevation on the vertex.

California; Mojave Region, Mr. Crotch. Nearly allied to the next species but more coarsely sculptured. The head of the male is retracted to such an extent that I cannot see distinctly whether it is excavated or flat, but I think the latter is the case.

13. **P. nitidulus.** *Bostrichus nit.* Mann., Bull. Mosc., 1843, 298; 1846, 359; *Cryphalus nit.* Lec., Trans. Am. Phil. Soc. 1868, 157; *C. atratulus* Lec., ibid., 156; ? *P. cribripennis* Eichhoff, Berl. Ent. Zeitsch. 1868, 274; ibid., 1871, 137.

♂. Head flat, finely punctured, not opaque; clothed with long, erect yellow hairs.

♀. Head much less hairy; elytra more retuse behind.

Alaska and California. Examination of a larger series of specimens indicates that the synonym was founded upon a slight individual variation in the form of the prothorax. Length 2 mm.; .08 inch.

14. **P. puncticollis.** *Cryphalus punct.* Lec. Trans. Am. Ent. Soc. 1874, 71.

California, one ♂. Closely related to *P. nitidulus*, and with the same sexual differences, but much smaller, and of a reddish brown color, with the rows of punctures on the elytra more distant, and a little finer. Length 1.5 mm.; .06 inch.

15. **P. lautus** Eichhoff, Berl. Ent. Zeitschr, 1871, 135.

A very small specimen from Texas closely resembles *P. puncticollis*, but the asperities of the prothorax are arranged in four or five transverse rows; the punctures of the rows of the elytra are larger, and the rows are better defined; the declivity as in that species is retuse, and deeply sulcate along the suture. Length 1.5 mm. .06 inch.

16. **P. puberulus** *Cryphalus pub.* Lec., Trans. Am. Ent. Soc. 1868, 157.

One ♀, District of Columbia; Mr. Ulke. Easily known by the very small size and erect pubescence. The elytra are finely and densely punctulate, and not retuse behind, though the sutural stria is deeply impressed. Length less than 1.5 mm.; .06 inch.

Digitized by Google

17. **P. digestus.** *Cryphalus dig.* Lec., Trans. Am. Ent. Soc. 1874, 171.

Mojave Desert, California; Mr. Crotch. Eleven specimens without sexual differences, all having the head punctured and finely carinate. The elytra are confusedly punctured, but the punctures have a tendency to form rows; they are not retuse behind, but the sutural stria is deeply impressed. Length 1.7 mm.; .07 inch.

18. **P. comatus.** *Crypturgus com.* Zimm., Trans. Am. Ent. Soc. 1868, 148.

South Carolina; Dr. Zimmermann. The specimen is a ♂, and has the head nearly smooth, broadly and deeply concave, thinly fringed with not very long yellow hair. The species is easily recognized by the large elliptical patch of yellow hair each side of the prothorax, and by the fine distant rows of elytral punctures; the declivity is not retuse, and the sutural stria is deeply impressed. The club of the antennæ is divided by three distinct straight sutures. I am not certain of the number of divisions in the outer part of the funicle. Length 1.8 mm.; .07 inch.

It is possible that *P. infans* Eichhoff, Berl. Ent. Zeitsch, 1871, 135, may be the ♀ of this species. It is, however, unknown to me, and I have seen nothing that corresponds with the description.

HYPOTHENEMUS Westwood.

The species I refer to this genus agree in having the outer part of the funicle of the antennæ very short, shorter in fact than the first joint, and very indistinctly divided; in the first species only by one transverse suture; but in *H. dissimilis*, the divisions seem more numerous, probably three, but so indistinct that they are without value. The head is larger and more exserted than in the preceding genera; eyes narrowly emarginate; the club of the antennæ is round, compressed, moderate in size, and divided by straight sutures on both sides. The tarsi are distinctly 5-jointed, the third joint rather longer than the first or second; the fourth small as usual; fifth elongate. The tibiæ are distinctly serrate towards the tip. The declivity of the elytra is not retuse or sulcate.

A. Body cylindrical, asperities of prothorax acute and numerous.

Brown, hairs stout, clavate, erect, finely striate like the spines of some Echini .... 1. **hispidulus.**

B. Body stouter, prothorax more rounded, with fewer and larger asperities.

Hairs erect stout, clavate .... 2. **erectus.**

Hairs slender, longer .... 3. **dissimilis.**

C. Body elongate; prothorax with scarcely any asperities.

Elytra very strongly punctate-striate .... 4. **striatus.**

1. **H. hispidulus.** *Cryphalus hisp.* Lec., Trans. Am. Ent. Soc. 1868, 156.

Middle and Southern States. Exactly resembles in appearance *H. eruditus* w.w. (specimens of which I owe to the kindness of Professor Westwood), but is rather larger, and the head and prothorax are dark piceous,

Digitized by Google

like the elytra. It varies much in size, one specimen from Florida being scarcely larger than *H. eruditus*. Length 1-1.5 mm.; .04-.06 inch.

This is probably *Stephanoderes seriatus* Eichhoff, Berl. Ent. Zeitsch. 1871, 133; but the head is not retracted into the prothorax. There are 6-8 small teeth on the apical margin, just as in *H. eruditus*.

2. **H. erectus**, n. sp.

Elongate-oval, rather robust, brown, thinly clothed with short pubescence, which is stout and erect especially near the tip of the elytra. Head large, exserted, opaque; with a somewhat sericeous lustre from extremely minute striæ; front flattened. Prothorax not longer than wide, very convex, rough in front with a few large acute elevations, general surface finely punctured. Elytra blackish, with lightly punctured striæ becoming deeper towards the sides. Antennæ and legs yellowish. Length 1.7 mm.; .07 inch.

Two specimens, Texas; Belfrage. This species closely resembles the next, and only differs by the shorter and stouter hairs of the elytra, which are almost as in *H. eruditus*. There are not more than ten or twelve acute tubercles on the front part of the prothorax; and there are two small approximate teeth on the apical margin itself.

It is quite possible that this is *Stephanoderes Chapuisii* Eichhoff, Berl. Ent. Zeitschr. 1871, 132; but the head is not retracted into the prothorax, as required by the generic description.

3. **H. dissimilis**. *Crypturgus diss.* Zimm., Trans. Am. Ent. Soc., 1868, 144.

Lake Superior to Georgia. Larger and stouter than the preceding, with the pubescence longer and finer; the apical margin of the prothorax has two approximate erect teeth. I observe no sexual differences in the seven specimens examined. Length 2 mm.; .08 inch.

The size and specific characters agree moderately with those of *Cryphalus robustus* Eichhoff, loc. cit., 1861, 130.

4. **H. striatus** *Cryphalus str.* Lec., Trans. Am. Ent. Soc. 1868, 156.

California, Lower and Upper, and Illinois. Resembles somewhat, in appearance, the Azorian genus *Liparthrum*, but differs by the tarsi having the joints 1-3 equal and distinct.

♂. Head punctured, with a large transverse frontal elevation.

♀. Head punctured, with a small round frontal fovea.

Group II. **Xyloteri.**

The insects of this group are rather robust and cylindrical; the declivity of the elytra is oblique, not excavated and not toothed. The eyes are completely divided, and the club of the antennæ is oval, solid, pubescent on both sides, and not annulated. The tibiæ are broad, rounded at tip, and serrate on the outer and terminal edge. The tarsi are slender, the fourth joint small, as usual, and the fifth long, with simple divergent claws. The species bore deeply into the wood of the trees they attack, thus injuring the timber much more than the subcortical *Tomici*.

Digitized by Google

XYLOTERUS Er.

In this genus the club of the antennæ is oval, compressed and solid, without articulations; the basal shining corneous part extends forwards in a narrow band as far as the middle, except in *X. politus*, where it is entirely basal, and the club is indistinctly divided by one round suture; the rest of the surface is opaque, finely pubescent and sensitive. The funicle is composed of two parts, as in the two preceding genera; the first joint is large, and stout as usual, the remaining part is about equal in length, forming a pedicel to the club, and is divided by two not well marked transverse sutures, thus causing the funicle to be 4-jointed. The eyes are moderately finely granulated and completely divided. The head is large, exserted, and in the ♂ is deeply concave. The prothorax is broader than long, and strongly asperate in front in the ♀, less so in the ♂. The tibiæ are dilated, finely serrate on the outer edge, rounded at tip, and very feebly mucronate at the inner angle; the tarsi have the joints 1–3 rather stout, nearly equal in length; fourth very small, fifth slender, as long as the second and third united, with simple divergent claws. The hairs are not serrate or verticillate, as in *Pityophthorus*, but slender and smooth.

The four species in our fauna are easily recognized:

Elytra with well defined striæ of punctures, interspaces nearly smooth.................................. **2.**

Elytra with ill-defined distant rows of punctures, interspaces equally strongly punctured, pubescence erect, abundant.................................. **4. politus.**

2. Prothorax finely and sparsely punctured at the sides towards the base.............................. **1. retusus.**

Prothorax finely but less sparsely punctured at the sides towards the base......................... **2. bivittatus.**

Prothorax scabrous and granulate behind the middle **3. scabricollis.**

1. **X. retusus** Lec., Trans. Am. Ent. Soc. 1868, 158.

Canada one ♂. It is quite possible that this is only an extraordinarily developed specimen of the next, but as I have seen no intermediate forms, I would suggest that for the present, it be retained as a distinct species. It is of larger size, (4.5 mm.; .18 inch), rather stouter, with the prothorax more suddenly declivous, and distinctly retuse in front, and less punctured on the sides behind the middle. Otherwise the differences are chiefly in color, which is of no value in this genus.

2. **X. bivittatus** Mannh., Bull. Mosc. 1853, 236; *Apate biv.* Kirby, Faun-Bor. Am. iv, 192, pl. 8, f. 5; *Bostrichus cavifrons* Mannh., Bull. Mosc. 1843, 297 (♂); ibid. 1852, 359; *Xyloterus cav.* Mannh., ibid. 1852, 385.

Maine, Canada, Alaska, Vancouver Island. Length 3–3.3 mm.; .12–.13 inch. Varies greatly in color. Usually the front part of the prothorax, the suture and the margin of the elytra are black; sometimes only a short, pale stripe is seen on each elytron.

Digitized by Google

3. **X. scabricollis** Lec. Trans. Am. Ent. Soc. 1868, 158.

District of Columbia, one ♂; Mr. Ulke. This species has entirely the form and sculpture of *X. bivittatus*, except that the prothorax instead of being punctured behind the middle, is covered with flat granules, produced by anastomosing rugæ, and the front part is as rough as in the ♀ of *X. bivittatus*. The striæ of punctures on the elytra are also deeper, and the color is different; the head and elytra are piceous, and the prothorax dull, ferruginous; the antennæ and legs, as usual, are yellow testaceous. Length 3.5 mm.; .14 inch.

4. **X. politus** Say, Journ. Ac. Nat. Sc. v, 256 (*Bostrichus*); ed. Lec. ii, 318; Lec., Trans. Am. Ent. Soc. 1868, 159.

Massachusetts to Kansas and Georgia. Length 3.3 mm.; .13 inch.

I have received specimens from Mr. J. A. Lintner, as depredating upon maple trees. Easily known by being more hairy than the other species, with the interspaces of the elytra sparsely punctured, so that the rows of punctures appear confused. I observe no sexual difference in the specimens before me, and the species may readily be separated as a distinct genus, by any one who will avail himself of the characters in the antennal club, which I have pointed out above.

X. unicolor Eichhoff, Berl. Ent. Zeitschr., 1871, 136, is unknown to me, but seems to be allied to *X. politus*.

Group III. Xylebori.

The essential character of this group is that the club of the antennæ is entirely corneous, and not articulated on the inner surface; on the outer surface it is also corneous, except towards the distal end, where it is obliquely truncate; the truncate surface is pubescent and sensitive, and has three concentric or transverse sutures, which indicate the other joints of the club. The scape of the antennæ is elongate, and the funicle usually distinctly 5-jointed, though in some species there appear to be but four joints. The tibiæ are dilated, more or less serrate, and spinose on the outer margin, with the apex obtusely rounded, and the inner angle not very strongly unguiculate. The tarsi are slender; fourth joint small, fifth nearly as long as the others united; claws strong, divergent, simple.

Sensitive surface of antennæ concentrically annulated... **XYLEBORUS.**
Sensitive surface of antennæ with straight, transverse sutures.. **DRYOCŒTES.**

XYLEBORUS Eichhoff.

A. Body stout, cylindrical; declivity of elytra oblique, scarcely flattened: funicle of antennæ with four distinct joints; tibiæ finely serrate on the distal half of their length, and rounded at tip.

Declivity of elytra without elevated granules...... 2.
" " with a few acute " .... 1. **tachygraphus.**
2. Cylindrical, rather elongate...................... 2. **pyri.**
Very stout, oval cylindrical...................... 3. **obesus.**

Digitized by Google

B. Body elongate, cylindrical; declivity of elytra oblique, frequently retuse or excavated; funicle of antennæ with five distinct joints; tibiæ rounded at tip, and finely serrate, except in the species under 6.

Declivity of elytra flattened; tibiæ finely serrate.. 2.
" " deeply impressed along the suture, tibiæ more coarsely serrate, not rounded at tip.................................. 6.

2. Declivity with a few prominent tubercles......... 3.
" with rows of small granules............ 5.

3. Prothorax deeply impressed in front.............. 4.
" not impressed; declivity with two acute tubercles each side, and some smaller marginal ones.................. .... **4. celsus.**

4. Declivity with one large, acute tubercle.......... **5. fuscatus.**
" with a few prominent acute tubercles.... **6. biographus.**
" " but two very small granules........ **7. retusicollis.**

5. Declivity of elytra with four or five granules on the first, third and fifth interspaces.......... **8. xylographus.**
Declivity of elytra with two or three granules on the first, third and fifth interspaces........... **9. pubescens.**

6. Declivity of elytra oblique, not sharply margined.. 7.
" " nearly perpendicular.......... 8.
" " with acute edge.............. 9.

7. " " " two prominent tubercles, and some smaller marginal ones; elytra strongly punctured in rows, interspaces with rows of distant punctures.................... ..... **10. cælatus.**
Declivity with two prominent tubercles, and some very indistinct marginal ones, elytra with rows of rather distant punctures................. **11. impressus.**
Declivity with some marginal tubercles, and two discoidal ones, with a third subsutural one, at the anterior part of the declivity, punctures distant, not arranged in rows.................. **12. sparsus.**

8. Declivity nearly perpendicular, without discoidal tubercles, sharply margined, and armed with teeth in ♀, of which the upper one is hooked; obtuse and feebly toothed in ♂; elytra with distant punctures not arranged in rows....... **13. plagiatus.**

9. Declivity nearly perpendicular, acutely margined, armed with a small tooth near the apex, and a long hooked process near the anterior end. Elytra with rows of feebly impressed small punctures................................ **14. hamatus.**

C. Prothorax densely punctured, not roughened in front, but broadly flattened, disc feebly and broadly sulcate; tibiæ finely serrate below, coarsely

Digitized by Google

so above, rounded at tip; funicle of antennæ stouter, more closely connected with the club.

Elytra with approximate, ill-defined rows of feeble punctures; declivity flattened in ♂ with a few small acute granules; concave in ♀, with three or four prominent tubercles on the obtusely elevated margin............................ **15. planicollis**.

1. **X. tachygraphus**, Zimm., Tr. Am. Ent. Soc. 1868, 440.

Middle and Southern States. Received from Col. Motschulsky, under the name *Corthylus denticulatus*.

2. **X. pyri** Zimm., l. c. 144; *Scolytus pyri* Peck., Mass. Agr. Journal, 1817, No. 3; *Tomicus pyri* Harris, Inj. Ins. ed. ult. 91.

Eastern and Middle States. Sometimes quite injurious to pear trees.

3. **X. obesus** Lec., Trans. Am. Ent. Soc. 1868, 159.

Canada to Virginia.

4. **X. celsus** Eichhoff, Berl. Ent. Zeitschr. 1867, 400; Zimm., Tr. Am. Ent. Soc. 1868, 145.

Middle and Southern States; under oak bark.

5. **X. fuscatus** Eichhoff, l. c., 1867, 400; Zimm., l. c. 1868, 145.

Virginia to Texas: under oak bark. The nearly allied species mentioned by me as occurring under pine bark in Georgia seems not to differ specifically from *X. impressus* mentioned below.

6. **X. biographus** Lec., Tr. Am. Ent. Soc. 1868, 160.

One specimen, Illinois.

7. **X. retusicollis** Zimm., Tr. Am Ent. Soc. 1868, 146.

One specimen, Maryland; under oak bark.

8. **X. xylographus** Zimm., Tr. Am. Ent. Soc. 1868, 145; *Bostrichus xylogr.* Say, Journ. Ac. Nat. Soc. Phil. v, 256; ed. Lec. ii, 318: *X. pini* Eichhoff, Berl. Ent Zeitschr. 1867, 401.

Atlantic and Pacific districts; under pine bark; abundant.

9. **X. pubescens** Zimm., Tr. Am. Ent. Soc. 1868, 145.

Middle and Southern States.

10. **X. cælatus** Zimm., Tr. Am. Ent. Soc. 1868, 146; *Tomicus cæl.* Eichhoff, Berl. Ent. Zeitchr. 1867, 402; *X. vicinus* Lec., Tr. Am. Ent. Soc. 1874, 72.

Canada to Texas and California. In this and the four following species the sensitive annulated surface of the club is larger than in the preceding species, and the tibiæ are more strongly serrate. The specimens from the Pacific Coast do not differ sufficiently to warrant their being known as a distinct species.

11. **X. impressus** Eichhoff, Berl. Ent. Zeitschr. 1867, 400.

One specimen, Georgia; under pine bark.

12. **X. sparsus** Lec., Tr. Am. Ent. Soc. 1868, 160.

Canada and Lake Superior.

Digitized by Google

13. **X. plagiatus** Lec., Tr. Am. Ent. Soc. 1868, 161.

Maryland; Mr. Ulke; this species is remarkable for the sexual differences. The declivity of the elytra is oblique, and the surface is without tubercles, but the sutural stria is deeply impressed; in the ♂ there are two or three small acute granules on the obtusely rounded margin of the declivity, but in the ♀ these are much more prominent, and the anterior one near the suture is hooked.

14. **X. hamatus** Lec., Tr. Am. Ent. Soc. 1874, 80.

Mojave Desert, California. No sexual difference observed in ten specimens examined.

15. **X. planicollis** Zimm., Tr. Am. Ent. Soc. 1868, 145.

Maryland and District of Columbia; two specimens.

DRYOCŒTES Eichhoff.

In this genus the prothorax is not or but slightly roughened in front; it is less prolonged over the head than usual; the elytral declivity is oblique, hardly flattened, not armed with tubercles; tibiæ strongly serrate. The club of the antennæ is obliquely truncate, with the sensitive surface divided by transverse straight sutures.

Larger, prothorax strongly punctured, not roughened in front.................................... 1. **septentrionis.**
Smaller, prothorax strongly punctured, slightly roughened in front........................ ...... 2. **affaber.**
Smaller, prothorax uniformly densely granulate, elytra with deeper striæ.............................. 3. **granicollis.**

1. **D. septentrionis.** *Bostrichus sept.* Mann. Bull., Mosc., 1843, 298; *B. semicastaneus* Mann., ibid. 1852, 358; *Xyleboris sept.* Lec., Tr. Am. Ent. Soc. 1868, 161.

Alaska, Canada, Virginia; under pine bark. Length 4.4 mm.; .17 inch.

2. **D. affaber.** *Bostrichus aff.* Mann., Bull. Mosc. 1852, 359; *Xyleborus aff.* Lec., Tr. Am. Ent. Soc. 1868, 162.

Alaska, British Columbia, Lake Superior. Length 2.7 mm.; .11 inch.

3. **D. granicollis.** *Xyleborus gran.* Lec., Tr. Am. Ent. Soc. 1868, 162.

Pennsylvania and District of Columbia. Length 2 mm.; .08 inch.

CRYPHALUS Er.

The species of this genus are of very small size, not very slender form, and clothed with erect stout bristles; the funicle is composed of four joints, of which the first is larger and stouter, and the other three form a conical mass, thicker outwardly. The club is compressed, rounded-oval, entirely corneous and without sutures on the inner side, with straight or curved sutures on the outer side, eyes large, not emarginate; the prothorax has but few large acute tubercles in front; the elytra are punctured in rows, and the declivity is convex, not impressed; the tips are conjointly rounded. The first and second ventral segments are very large, the others very short. The tibiæ are only slightly dilated and scarcely perceptibly serrate.

Digitized by Google

1. **O. rigidus**, n. sp.

Dark brown, somewhat shining, of stout cylindrical, somewhat oval form, clothed with rather long erect pale bristles. Prothorax a little wider than long, convex, anterior edge not toothed, disc with a few distant acute tubercles in front of the middle, sparsely punctured behind. Elytra punctured in rows, setigerous punctures of the interspaces very small. Legs and antennæ yellow-brown; club oval, hairy, sutures curved, surface rather shining. Length 1 mm.; .04 inch.

♂. Front with a small rounded polished excavation.

Canada, five specimens, Dr. Horn. This species does not agree very satisfactorily with the descriptions of European authors, and I therefore venture to describe it as new.

2. **O. striatulus** Mann. Bull. Mosc., 1853, 235, Alaska, and

3. **O. robustus** Eichhoff, Berl. Ent. Zeitschr., 1871, 131, Am. bor.? are unknown to me.

Group. IV. **Tomici.**

The species of this group are of cylindrical, but not very slender form, and are easily recognized by the deeply excavated elytral declivity, which is sharply margined and acutely toothed. The club of the antennæ, as in the group *Xylebori*, is entirely corneous on the inner face, but is not obliquely truncate on the outer face. The sensitive surface is more or less distinctly defined, and is divided by two sutures which are more or less curved or angulated in our species, but are described in some European species as straight, thus showing an affiliation with *Dryocœtes* of the preceding group. The tibiæ are coarsely serrate, and the tarsal joints 1–3 are rather stouter than in the preceding groups.

Our species represent but one genus, which may be divided conveniently according to the form of the sutures of the antennal club.

TOMICUS Latr.

	Sutures of antennal club strongly angulated.....	2.
	First suture of club nearly straight, second bisinuate..................................	3.
	Sutures of club nearly straight..................	8.
	Sutures of club regularly curved, not angulated..	9.
2.	Margin of declivity with three teeth behind the most prominent one......................	1. **calligraphus.**
	Margin of declivity with two teeth behind the most prominent one, punctures and interspaces regular.............................	2. **cacographus.**
	Margin of declivity with two teeth behind the most prominent one, punctures and interspaces confused...	3. **confusus.**
	Margin of declivity with but one tooth behind the most prominent one........................	4. **plastographus.**

Digitized by Google

3. Margin of declivity with three prominent teeth each side..................................	4.
Margin of declivity with but two prominent teeth, the posterior longer, emarginate at tip........	5. **emarginatus.**
4. Cusps of the teeth, separate. acute..............	5.
Anterior teeth united, front cusp rectangular	6. **rectus.**
5. Elytral striæ composed of larger more distant punctures...................................	6.
Elytral striæ composed of smaller approximate punctures..................................	7. **pini.**
6. Interspaces with rows of distant punctures extending nearly to the base..................	7.
Interspaces with punctures only near the declivity	8. **hudsonicus.**
7. Punctures of striæ moderately distant	9. **interruptus.**
" " more distant......................	10. **tridens.**
8. Smaller, last tooth small, acute	11. **avulsus.**
Last tooth long and slender, declivity more deeply concave..................................	12. **latidens**
9. Elytra more densely punctured, and scarcely in rows, posterior declivity less concave, with the lower tooth long and prominent...............	13. **concinnus.**

1. T. **calligraphus** Germ., Ins. Nov. 461; *Bostrichus exesus* Say, Journ. Ac. Nat. Sc. v. 255; ed. Lec. ii., 317; Zimm., Trans. Ent. Soc. 1868, 147; ? *Tomicus præmorsus* Eichhoff, Berl. Ent. Zeitschr. 1867, 401.

Atlantic region, as far west as New Mexico. The usual size is 5 mm.; .20 inch, but two specimens from the locality last mentioned measure 6.4 mm.; .25 inch. The sutures of the club resemble figure 1, Ferrari, p. 44, and are quite like those of the European *T. stenographus*; which differs by its larger size, more coarsely punctured prothorax, and especially by having but two teeth on the edge of the elytral declivity behind the most prominent tooth.

For the purpose of making the distinctions between the species mentioned below more intelligible, I will describe the arrangement of the teeth in this species, in which the number is greatest. The declivity is deeply concave, polished, sparsely punctured, and the prolongation of the sutural stria is well impressed. At the posterior end of the second interspace is a small cusp, and a similar one at the end of the third interspace; these two small cusps or denticles are not mentioned in the synoptic table given above. At the end of the fourth interspace is a large conical tubercle, which in this species is but slightly connected with the tubercle of the fifth interspace, *which is always the most prominent.* Behind this prominent one there are in the present species three acute equidistant teeth, and the apical acutely elevated margin. The disappearance of some of these teeth in the following species is produced by their absorption in the acute terminal margin, which thus becomes longer, so that in *T. pini* it extends around fully one-third of the declivity.

Digitized by Google

The dimensions and relations of these teeth with each other, and the arrangement of the sutures of the antennal club give excellent characters for the discrimination of the species; and I hope that the student will have no difficulty in recognizing those I have admitted in this memoir. The descriptions of those named by Mr. Eichhoff are, however, too indefinite for me to venture to pronounce with certainty upon their affinities; they seem, moreover, if I may judge from the short diagnoses, to have been unduly multiplied upon individual differences of slight importance.

2. **T. cacographus** Lec., Tr. Am. Ent. Soc. 1868, 162; *Bostrichus pini* ‡ Zimm. (nec Say), ibid, 147.

Southern and Western States. Similar to the preceding, but usually of smaller size, (3.5–4 mm.; .14–.16 inch); the cusp of the second interspace is very small, and that of the third is wanting; that of the fifth is compressed and scarcely more prominent than that of the fourth interspace and is somewhat connected with it; there are but two teeth between the tooth of the fifth interspace and the terminal acutely elevated margin, and these teeth are all of them less prominent than in *T. calligraphus*, in some specimens (♂), but equally prominent in others, ♀, those less acute than in *T. caligraphus*. The interspaces from the third outward are marked each with a regular series of punctures behind the middle, whereby it differs from the next species. The club of the antennæ is quite similar to that of *T. calligraphus*.

3. **T. confusus**, n. sp.

Quite like *T. cacographus*, except that the elytral striæ are composed of larger and more transverse punctures; the punctures of the interspaces are very distant as far as the middle, but become irregular and confused with the striæ behind. The teeth on the margin of the declivity are arranged just as in *T. cacographus*, but are larger and stouter, and the one of the fifth interspace has a tendency to become curved at the end. The club of the antennæ as in the two preceding species. Length 4 mm.; .16 inch.

Southern California and Arizona. I have seen but three specimens.

4. **T. plastographus** Lec., Tr. Am. Ent. Soc. 1868, 163.

Middle California and New Mexico; two specimens. This species closely resembles *T. confusus* in the sculpture of the elytra, the interstrial punctures being confused behind, but on the inner interspaces from the third to the fifth there are no punctures except near the declivity. The tooth of the fourth interspace is more compressed and closely united with the very prominent tooth of the fifth interspace, which is cylindrical and obtuse; there is but one tooth between that of the fifth interspace and the apical elevated margin, but this is large and conical. The sutures of the antennal club are very strongly angulated. Length 4.5 mm.; .18.

5. **T. emarginatus**, n. sp.

Cylindrical, shining, blackish piceous, sparsely clothed with long yellowish hairs. Head granulated, with two small frontal elevations, the anterior one near the margin, which is fringed as usual with short yellow

Digitized by Google

hairs. Prothorax nearly one-half longer than wide, sides parallel, base broadly rounded, margined only near the side; anterior half of disc asperate with granules; posterior half strongly and tolerably densely punctured, without distinct dorsal smooth space. Elytra with striæ composed of strongly impressed transverse punctures, interspaces wide, 1–7 smooth except near the declivity, where there are a few punctures; outer interspaces with punctures gradually becoming confused near the sides; declivity deeply concave, strongly and coarsely punctured, with the sutural stria deeply impressed; the teeth of the second and third interspaces are small, but acute; that of the fourth is larger, conical and subacute; that of the fifth is large, compressed and emarginate; the interval between it and the apical elevated margin is wide, and in some specimens is marked by a single indistinct cusp; the apical margin is long, and its anterior angle is more prominent than usual; the sutural angle is slightly prominent, as is frequently the case in other species, a character of no importance. The sutures of the antennal club are nearly straight, slightly bent forwards at the sides. Length 6.6 mm.; .26 inch.

Oregon. Found in abundance by Lord Walsingham.

6. **T. rectus**, n. sp.

This species resembles the preceding in form and color; but is of smaller size, and the prothorax is less deeply punctured behind, with a distinct smooth medial space. The elytral striæ and interstrial punctures are similar, but the teeth of the declivity are quite different; the cusps of the second and third interspaces are small, but distinct and acute; that of the fourth is broad, compressed and closely united with that of the fifth, which forms a prominent tooth at its posterior extremity, the anterior extremity of this conjoined mass is not acute, but barely rectangular, and the apical acute margin is a rather large acute tooth. The body is thinly clothed with long yellow hair, especially in front and behind. The antennal club is marked with three sutures, the first and second curved at the middle, bent forwards at the side, and the third nearly straight. Length 4 mm.; .11 inch.

One specimen, New Mexico and two from Oregon. I should consider these as badly developed specimens of *T. plastographus*, except for the differences in the antennal club.

7. **T. pini** Harris, Inj. Ins. ed. ult. p. 88, f. 43; Lec., Tr. Am. Ent. Soc. 1868, 163; *Bostrichus pini* Say, Journ. Acad. Nat. Sc. Phil. v, 257; ed. Lec. ii, 219; *T. præfrictus* Eichhoff, Berl. Ent. Zeitschr. 1867, 401.

The elytral striæ are composed of small, transverse punctures; the interspaces are wide and flat, and are marked with only a few punctures near the declivity; the latter is deep, strongly punctured, as in all the preceding species, with the sutural stria deeply impressed; the tooth at the end of the second interspace is small, but acute and distinct; that of the third is wanting; that of the fourth and fifth are acute, and connected by an elevated ridge, behind them there is one acute compressed tooth, which is scarcely less prominent, and this is followed after a narrow interval by the apical margin.

Digitized by Google

The first and second sutures of the antennal club are broadly curved at the middle, and bent forwards at the sides as in the preceding species, *T. rectus*. Length 4 mm.; .16 inch.

Northern and Western part of Atlantic district, extending to Canada and Hudson Bay Territory. Harris, who is good authority upon Say's species, indicates this as the one described by that author. It is destructive to Northern pine forests in the same manner, but, as far as observation yet goes, to a less extent than *T. cacographus* is in the South. I have therefore felt warranted in rejecting Dr. Zimmermann's determination of Say's species, and have applied a different name to the insect which has caused so great destruction to the pine forests of the Southern States.

8. **T. hudsonicus**, n. sp.

Specimens of a larger size (5 mm.; .19 in.), from Hudson Bay Territory have the elytral striæ composed of much larger punctures, than in *T. pini*, and the tooth of the fifth interspace has a tendency to become thicker and curved. I would be unwilling to designate it by a separate name, were it not that the sutures of the antennal club are not bent forward at the sides, but are nearly straight.

9. **T. interruptus** Lec., Tr. Am. Ent. Soc. 1868, 164; Eichhoff, Berl. Ent. Zeitschr. 1868, 274; *Bostrichus int.* Mann., Bull. Mosc. 1852, 357.

Alaska and Hudson Bay Territory. The teeth of the margin of the declivity are arranged as in *T. pini*, and *hudsonicus*; the stria are composed of still larger punctures than in the latter, and the punctures of the interspaces extend forward, almost to the base.

10. **T. tridens** Lec., Tr. Am. Ent. Soc. 1868, 164; Eichhoff, Berl. Ent. Zeitschr. 1868, 274; *Bostrichus tr.* Mann., Bull. Mosc. 1852, 357.

The scutellum is described by Eichhoff as smooth, but in my specimens it is as distinctly channeled as in the five specimens of *T. interruptus*; as in fact it is in all the preceding species except *T. calligraphus* and *marginatus*; this channel is less distinct in *T. plastographus* than in the others, but at best, is an illusive character of but little worth.

Alaska, one specimen. Very similar to *T. interruptus*, but the punctures of the elytral striæ are larger and more distant, and those of the interspaces nearly as large, though less numerous. The head is more finely granulate, strongly retuse in front, with a broad frontal groove. This character is probably sexual rather than specific.

11. **T. avulsus** Eichhoff, Berl. Ent. Zeitschr. 1867, 402; *Bostrichus av.* Zimm., Tr. Am. Ent. Soc. 1868, 147.

Southern States. A much smaller species (2.5 mm.; .10 inch); the elytral striæ are composed of close-set quadrate punctures; the interspaces are wide, and as far as the sixth have only a few punctures near the declivity; the latter is more abrupt than in the others, and nearly perpendicular, but deeply concave, and coarsely punctured, as usual, with the sutural stria deeply impressed; the tooth at the end of the second interspace is small, but well defined; that of the third is wanting; those of the fourth and fifth are

Digitized by Google

united by a ridge, the angles of which are very little prominent; the apical ridge is long, and between it and the last mentioned tooth is an acute tooth which is equally prominent. The prothorax is nearly as long as the elytra, more finely and densely asperate in front, and more finely punctured behind. The sutures of the antennal club are nearly straight.

12. **T. latidens** Lec., Tr. Am. Ent. Soc. 1874, 72,

California, at Lake Tahoe; Mr. Crotch. This species is smaller (3 mm.; .14 inch), than *T. pini*, and of more slender form. It is easily distinguished from all the other species by the much more deeply concave declivity of the elytra; the cusp of the second interspace is acute; the teeth of the fourth and fifth are united together, forming a ridge which has three distinct cusps, of which the middle one is more prominent; the tooth between this ridge and the terminal margin is unusually prominent. The stria are composed of deep close-set punctures, and the interspaces are marked with rows of small punctures. The sutures of the antennal club are nearly straight.

13. **T. concinnus** Lec., Tr. Am. Ent. Soc. 1868, 164; *Bostrichus conc.* Mann., Mosc. 1852, 358.

Alaska, three specimens. Length 4.2 mm.; .17 inch. A very distinct species, with the elytra confusedly punctured; the declivity oblique, nearly flat, punctured, with the sutural stria scarcely distinct; the teeth are but three each side, of which the anterior one is small, and the third longer and larger than the second.

Group V. **Micracides.**

The funicle of the antennæ is 6-jointed, the outer joints broader; the club is pubescent and usually marked with sutures on both sides, as in the group *Corthyli*, but these sutures are usually very much curved, though sometimes nearly straight; the basal joint is long, and in one sex is fringed on the front margin with very long hairs; the eyes are transverse, coarsely granulated, either distant or contiguous beneath. The prothorax is produced over the head, rounded and asperate in front, and its anterior opening is very oblique as in most *Pityophthori*. The elytra are usually punctured in rows, convexly declivous behind, then concave near the tip, and sometimes asperate with small granules; the suture is produced into a sharp point, except in *T. fimbricornis*. The tibiæ are compressed, armed with a terminal hook, outer edge acute, not at all toothed (or but slightly so in *M. rudis*), and fringed with long hair; the front pair are as broad at base as at tip; the joints of the tarsi 1–3 are rather stout in all the species except *M. hirtella*, where they are longer and more slender, the fourth joint is small, and the fifth long, slender, with divergent simple claws. Although important structural differences are seen in the species, I regard them as constituting but two genera. This group is excellently defined by the 6-jointed funicle, and the broad parallel front tibiæ.

Digitized by Google

Club pubescent and annulated on both sides, outer joints of funicle slightly broader, not fringed; elytra aculeate at tip.................................... **MICRACIS.**

Club sparsely hairy, corneous, without sutures on upper surface; with two indistinct sutures on the lower surface; outer joints of funicle transversely produced, fringed with long hairs; elytra not aculeate. **THYSANOES.**

MICRACIS Lec.*

Sutures of club forming narrow curves................ **2.**

" " " broad curves.................. **4.**

" " " nearly straight................ **5.**

2. Eyes distant beneath.... .... **3.**

Eyes contiguous beneath, elytra more finely punctured, clothed with very short stout hair.................. **3. nanula.**

3. Elytra nearly glabrous................................ **1. suturalis.**

" clothed with short stout hair..................... **2. aculeata.**

4. Elytra nearly glabrous, with rows of coarse punctures, asperate near the tip................................ **4. rudis.**

5. Elytra sparsely clothed with long hair, punctured in rows, asperate behind............................. **5. hirtella.**

1. **M. suturalis** Lec., Tr. Am. Ent. Soc., 1868, 165.

Illinois, boring in the branches of *Xanthoxylon*: Dr. Henry Shimer. The club of the antennæ is more than one-half longer than wide; the gular space between the eyes is wide; the punctures of the elytra are fine and arranged in numerous distinct rows; there are a few short hairs near the tip in some specimens, but in others even these are wanting. Length 2.5 mm.; 10 inch.

2. **M. aculeata** Lec., ibid. 1868, 165.

Virginia, one specimen. The antennal club is of the same form as in *M. suturalis*, and the eyes are as widely separated below; the elytra are clothed with short sub-erect yellowish hairs, which are slightly clavate; the punctures are larger and denser than in the preceding, and not arranged distinctly in rows, though owing to the manner in which the short bristles are placed the interspaces are feebly indicated. Length 2.7 mm.; .11 inch.

3. **M. nanula** n. sp.

Slender cylindrical, much smaller and narrower than the other species, brown; antennæ reddish-brown, with the first joint fringed with long hair; club but little longer than wide, sutures forming less narrow curves. Eyes contiguous beneath; prothorax one-half longer than wide, nearly opaque, sparsely and finely granulate behind, asperate with small acute distant tubercles in front; very thinly pubescent, with short erect hair, especially towards the sides. Elytra somewhat shining, feebly and indis-

* I have in the synopsis incorrectly described the funicle as 5-jointed.

Digitized by Google

tinctly punctured, with numerous rows of short pale bristles; posterior declivity convex, sutural point small, less prominent than in the other species. Length 1.7 mm.; .07 inch.

Haulover, Florida; February, Messrs. Hubbard and Schwarz. One specimen. The eyes are more coarsely granulated than in the other species, and there is no gular space between them.

4. **M. rudis**, n. sp.

Cylindrical, proportioned like *M. suturalis*, nearly black, rather shining, antennæ reddish-brown, sutures of the club forming broad curves; first joint with a tuft of hairs near the tip. Head very deeply excavated (almost as in *Xyloterus* ♂); eyes widely distant below. Prothorax somewhat longer than wide, broadly rounded in front, sides parallel behind; surface sparsely granulate behind, rough with numerous tubercles in front. Elytra scarcely pubescent, rugosely punctured; punctures large, arranged in approximate rows; interspaces rough with small acute tubercles on the declivity which is convex, except near the tip, which is concave; sutural point well developed. Length 2.5 mm.; .10 inch.

Detroit, Michigan; Messrs. Hubbard and Schwarz; one specimen. The tibiæ are feebly toothed on the outer edge.

5. **M. hirtellus**, n. sp.

Cylindrical, of the same form as *M. suturalis*, dark brown, thinly pubescent with fine yellowish sub-erect hair. Head flat, with a frontal tuft of hair; eyes widely separated beneath. Antennæ with the scape more densely fringed than usual; club small, rounded; sutures nearly straight. Prothorax longer than wide, nearly semicircular in front, densely but finely granulate behind; asperate with numerous sharp tubercles in front, disc feebly impressed, and more hairy each side of the median line behind the middle. Elytra rugosely punctured; punctures arranged in rows; declivity rough with small tubercles; convex, sutural point prominent. Length 2.7 mm.; .11 inch.

One specimen from Southern California, collected by Mr. Hardy and kindly given me by Dr. David Sharp. The tarsi are longer and more slender than in the other species.

THYSANOES n. g.

This genus is allied to *Micracis*; the front tibiæ are of the same parallel form, as wide at base as at tip, and not serrate on the outer edge; the antennæ are, however, quite different; the scape is fringed as in *Micracis*; the first joint of the funicle is longer than wide; thicker at the extremity; the remaining five joints are very distinctly separated, and become rapidly wider and transverse, by being prolonged at the upper side; they are also fringed with very long hair; the club is elliptical, compressed, rather shining, sparsely hairy, without distinct sensitive surface; without sutures on the inner face, with two indistinct sutures on the outer face, of which the lower one seems straight, and the distal one curved. The eyes are large, transverse, coarsely granulated, and not emarginate; they are separated beneath

Digitized by Google

by a wide gular space. The first and second ventral segments are very large, the others short.

1. **T. fimbricornis**, n. sp.

Slender, cylindrical, yellowish brown. Head (♂) shining, flattened, with a small fovea on the vertex. Prothorax longer than wide, sparsely asperate in front and slightly hairy, then not densely punctured for a short distance, and nearly smooth behind the middle, and at the sides. Elytra with rows of small punctures; punctures of the interspaces smaller and more distant, and from them proceed short, clavate, pale bristles in regular rows; declivity convex, not at all impressed or retuse, sutural line very slight. The eyes are transverse, slightly emarginate and coarsely granulated. Front tibiæ broad from the base, sides parallel, outer edge acute, not serrate. Length 1.8 mm.; .075 inch.

Lancaster County, Pennsylvania. Abundant in twigs of hickory; easily recognized by the characters given above. The first and second ventral segments are each as long as the others united; third, fourth, and fifth short, equal, last dorsal slightly visible from beneath. The bristles are not striate as in *Hypothenemus*, but finely granulated.

Tribe II. SCOLYTINI.

The species of this tribe are easily known by the peculiar conformation of the ventral surface, which is, namely, flattened or concave, and obliquely ascending from the posterior end of the first segment to the fifth; the first and second segments are closely connate, and the other three are separated by straight sutures, about equal in length, and united are hardly longer than the oblique part of the second segment. The antennal club is pubescent on both sides, nearly solid and marked with indistinct but strongly curved, or rather angulated, sutures; the scape is short, the first joint of the funicle rounded, the remaining joints (five in number) closely united forming a pedicel to the club. The thighs are stout, the tibiæ rather broad and compressed; the front pair are not serrate on the outer edge, which is quite sharp; the outer apical angle is armed with a long curved hook, and the inner angle is nearly rectangular but not armed with a spine; the outer margins of the middle and hind tibiæ are feebly serrate, they are truncate at tip, and armed with two spines or spurs at the *outer* angle, and a much smaller spine at the inner angle; the tarsi are slender, as long as the tibiæ; the third joint is deeply bilobed, the fourth small, the fifth long, with simple divergent claws.

The side margin of the prothorax is distinctly defined, a very rare character in Rhynchophora, and the front coxæ are separated by the prosternum, which is very short in front of the coxæ. In some of the species the ventral segments of the ♂ are ornamented with spines, or acute tubercles such as have been already mentioned in *Proctorus* (p. 212) and *Platypus* (p. 343).

But one genus represents this tribe.

Digitized by Google

SCOLYTUS Oliv.

The name of this genus was first proposed by Geoffroy in 1762; but for reasons which I have given in detail elsewhere,* I prefer citing Olivier, 1789, for its first proper use in Zoology.†

Elytra with distinct striæ of close-set punctures....	2.
Elytra with numerous rows of punctures..........	3.
2. Striæ deep, interspaces narrow with single rows of fine punctures bearing short hairs; (abdomen of ♂ with several spines)..............	1. **quadrispinosus.**
Striæ less deep, interspaces wider, with single rows of fine punctures; (abdomen of both sexes without spines, coarsely punctured)....	2. **fagi.**
Striæ hardly impressed, interspaces wide, with single rows of fine punctures; (abdomen ♂ with one spine at the middle near the base)..	3. **unispinosus.**
Striæ hardly impressed, interspaces wide towards the suture with confused small punctures; (abdomen finely punctured, third and fourth ventral segments with very small tubercles at the hind margin)........................	4. **californicus.**
3. Elytra nearly glabrous........................	4.
Elytra clothed with long fine erect hairs........	5. **muticus.**
4. Abdomen sparsely punctured..................	5.
Abdomen densely punctured, anterior face of declivity large, perpendicular, margined.......	6. **præceps.**
5. Punctures of elytra not larger towards the base..	6.
Punctures of elytra larger and somewhat scabrous towards the base..........................	7. **subscaber.**
6. Second ventral segment not tuberculate..........	8. **sulcatus.**
Second ventral segment with a small apical tubercle.................................	9. **ventralis.**

1. **S. quadrispinosus** Say, Journ. Ac. Nat. Sc. Phila. iii, 323, (♂); ed. Lec., ii, 182; Lec., Tr. Am. Ent. Soc. 1868, 165; *S. caryæ* Riley, Prairie Farmer, Febr. 1867; Walsh, Practical Entomologist, ii, 58; Lec., Tr. Am. Ent. Soc. (♀) 1868, 166; Riley, Noxious Ins. Missouri, (1873) v, 103, (♂, ♀); *S. muticus* ‡ Chapuis, (nec Say,) Mem. Soc.Roy. Sc. Liége, 1869.

♂. Head flat, longitudinally finely aciculate, fringed with long curled hairs; anterior part of ventral declivity very deeply concave; the margin is acute, subsinuate and more or less angulated at the middle; the concave face of the second segment is more or less carinate, and nearly smooth; the

* On some changes in the nomenclature of North American Coleoptera, which have been recently proposed. Canadian Entomologist, 1874, p. 185.

† The table of species in my memoir (Trans. Am. Ent. Soc. 1868, 165,) needs some modification on account of the discovery of additional species, and the sexual characters of some of those already described.

Digitized by Google

lateral angles are slightly produced into short spines; the next segment has three spines, which are sometimes very long, sometimes short; the fourth segment is concave, rounded and strongly margined behind, sparsely punctured, and has a more or less distinct tubercle at the middle of the hind margin; the fifth segment is very short, and retracted, visible only from behind.

♀. Head less flattened, punctured at the sides, aciculate only at the middle, thinly clothed with long hair; anterior face of ventral declivity flattened, margined, nearly perpendicular, sparsely punctured; remaining segments flat, strongly punctured; fifth rounded behind, as long as the third and fourth united.

New York, Georgia, Kansas, Missouri; for an excellent series bred from hickory trees, I am indebted to Mr. Riley. Length 4–5 mm.; .16 –.20 inch.

2. **S. fagi** Walsh, Practical Entomologist, ii, 58, (♂, ♀); Lec., Tr. Am. Ent. Soc. 1868, 166.

♂. Head flattened, punctured, densely clothed with long erect hairs; ventral surface strongly punctured, more sparsely in front; declivity margined, nearly perpendicular; fifth segment as long as the third and fourth longitudinally impressed.

♀. Head more convex, less hairy; the ventral segments more strongly punctured.

Illinois, one pair. Length 5.5 mm.; .22 inch. Depredates upon beech trees, according to Mr. Walsh.

3. **S. unispinosus**, n. sp.

Cylindrical, shining black, head aciculate, thinly clothed with long erect hairs. Prothorax a little longer than wide, sides rounded and feebly constricted in front, finely and not densely punctured. Elytra with feebly impressed striæ composed of small punctures; interspaces with single rows of much smaller punctures. Ventral declivity feebly punctured; anterior edge somewhat prominent, but obtuse at the middle; a long obtuse spine projects from the middle of the nearly perpendicular face; fifth segment hardly longer than the fourth, concave, rounded and strongly margined behind. Length 2.3–2.7 mm.; .09–.12 inch.

Two specimens, Oregon. The head is more flattened in one than in the other, but I observe no other indication of sexual difference. The antennæ are ferruginous, and the tarsi brown, as in the other species of the genus.

4. **S. californicus** Lec., Tr. Am. Ent. Soc. 1868, 166.

One ♂, California; Mr. A. Murray. Length 4.5 mm.; .18 inch.

5. **S. muticus** Say, Journ. Ac. Nat. Sc. Phila. iii, 323; ed. Lec., ii, 182; Lec., Tr. Am. Ent. Soc. 1868, 166.

Pennsylvania, one ♂. Easily known by the elytra with numerous rows of strong, but distant punctures, which bear long, erect, soft hairs. Head flat, finely aciculate, sparsely fringed with long hair. Ventral surface sparsely punctured; declivity oblique, margined; fifth segment triangularly

Digitized by Google

impressed and densely fringed with long hair behind. Length 3.8 mm.; .15 inch.

6. **S. præceps**, n. sp.

Cylindrical, black, shining, head thinly clothed with long erect hair, prothorax scarcely longer than wide, sides rounded in front and feebly constricted; surface deeply but finely and distantly punctured. Elytra with numerous rows of rather distant punctures, and showing some traces of very fine striæ; ventral surface strongly punctured in front, densely and finely behind; declivity large, perpendicular, acutely marginate; second ventral segment faintly carinate near the tip; fifth ventral concave, strongly margined, as long as the third and fourth united. Length 3 mm.; .12 inch.

California, Calaveras; Mr. Crotch. The head of the ♂ is more flattened, more distinctly aciculate and less punctate than in the ♀, and is also more hairy. Otherwise I observe no sexual differences.

7. **S. subscaber**, n. sp.

Cylindrical, black, shining, head thinly clothed with erect hairs, finely aciculate behind, punctulate in front. Prothorax a little longer than wide, sides feebly narrowed, and slightly constricted in front; apical margin and sides distinctly punctured, disc behind obsoletely punctulate. Elytra with the suture more deeply concave towards the base than usual; marked with faint traces of striæ, and rows of punctures which are very small behind, but become larger and elevated into granules near the base; the apical margin is concave, and densely, rugosely punctured as usual, and very feebly serrate. Ventral declivity flat, oblique, scarcely concave, feebly punctured, anterior margin fine, not prominent; fifth segment longer than the third and fourth united, slightly concave; posterior margin acutely prominent. Length 4.2 mm.; .17 inch.

Vancouver Island, Oregon and California; three specimens without sexual differences.

8. **S. sulcatus** Lec., Tr. Am. Ent. Soc. 1868, 167.

One specimen, New York. The rows of punctures are alternately very slightly larger, so that in certain lights there are feeble indications of striæ, but they are not coarser near the base. Length 3.7 mm.; .15 inch.

9. **S. ventralis** Lec., ibid. 1868, 167.

Washington Territory, George Gibbs. Similar in sculpture to *S. sulcatus*, but the ventral declivity is larger, the second segment is armed behind with an acute compressed tubercle, and the third and fourth segments are more flattened, and less sparsely punctured; the fifth segment is as long as the two preceding united, concave, with reflexed posterior margin. Length 4 mm.; .16 inch.

Tribe III. HYLURGINI.

In this tribe the head is exposed, not covered by a prolongation of the prothorax; the latter is truncate in front or but slightly rounded, and not differently sculptured. The antennæ vary in form according to the group,

Digitized by Google

and in *Hylastes* assume very much the same form as in *Cossonidæ*, to which some of these insects bear a strong resemblance. They may be distinguished, however, by the compressed and serrate or spinulose tibiæ.

The third joint of the tarsi is frequently dilated and bilobed, and the fourth joint, less conspicuous than in the preceding tribes, is sometimes quite indistinct. The first and second ventral segments are always separated by a well-defined straight suture, more deeply impressed than in *Tomicini*.

The prothorax is bisinuate behind, with a well defined antescutellar angle in some of the species of all the groups except *Hylastes*. They thus manifest a tendency to the *Anthribidæ* (*Choragus*, &c.), as *Hylastes* does towards the *Cossonidæ*.

In several genera the front coxæ are separated by the prosternum, and in *Dendroctonus* and the allied European genera *Hylurgus* and *Blastophagus* the second and third ventral sutures are curved backwards at the sides. In *Hylastes* the prosternum is deeply excavated for the reception of the short beak. In all these characters resemblances are seen to different tribes of *Curculionidæ*.

Our genera indicate the following groups:

Club oval, annulated, scarcely compressed.................. 2.
" strongly compressed, not annulated, pubescent on both sides...**Polygraphi.**
2. Joints of club separated...................................**Phlœotribi.**
" " closely connate, as usual.................. 3.
3. First and fifth ventral segments elongated, scutellum not depressed.. 4.
Ventral segments nearly equal and scutellum depressed.... **Hylurgi.**
4. Prosternum very short, funicle with few joints........... **Crypturgi.**
Prosternum excavated; funicle 7-jointed................ **Hylastes.**

Group I. **Polygraphi.**

This group is sufficiently defined by the club of the antennæ being large, strongly compressed, pubescent and sensitive, and without sutures on both sides, and by the antennæ being inserted as usual at the sides of the front. The tibiæ are broadly dilated, obliquely rounded at the apex, and finely serrate; the third joint of the tarsi is not bilobed, and the fourth, though small, is distinct. The basal margin of the elytra is acute and serrate.

Two genera occur in our fauna:

Eyes slightly emarginate, funicle attached at the side of the club, outer joints slender......... **CHRAMESUS.**
Eyes completely divided, funicle attached at the end of the club, outer joints gradually stouter **POLYGRAPHUS.**

CHRAMESUS Lec.

Rhopalopleurus Chap.

Body stout, oval, convex, clothed with small scales and stout, erect bristles, which are not striate as in *Hypothenemus hispidulus* (p. 355).

Digitized by Google

Head but slightly prolonged in front of the eyes, which are large transverse, rather finely granulated, slightly emarginate at the insertion of the antennæ. Antennæ inserted at the sides, scape long, slender, curved, funicle 5-jointed, first joint stouter, a little longer than wide; 2–5 slender, closely united, attached to the side of the club, which is very large and strongly compressed, pubescent on both sides, not marked with sutures; the lower edge is nearly straight, the upper is curved and sinuate, and each end is obtusely rounded. Ventral surface moderately convex, sutures straight, well impressed, first and second segments a little longer. Tibiæ dilated, finely serrate on the outer side and at the tip, which is broadly rounded; apical spine at the inner angle short; tarsi with joints 1–3 short, fourth small, but distinct; fifth as long as the others united, with large simple divergent claws.

Bristles long, scales of elytra sparse...................... 1. **icoriæ.**
Bristles short, scales dense.............................. 2. **Chapuisii.**

1. **C. icoriæ** Lec., Tr. Am. Ent. Soc. 1868, 168; *Rhopalopleurus Lecontei* Chapuis, Mem. Soc. Roy. Sc. Liége, 1869.

♂. Head deeply concave.

♀. Head flattened, with a feeble curved impression.

Middle and Western States, in hickory twigs. The present is an excellent example of the uncertainty of entomological descriptions. In the memoir above cited, I described the funicle as having but one distinct joint, "the remaining joints are obsolete, and visible only as a corneous ridge on the upper edge of the base of the club," which, in fact, was the appearance presented by all the specimens in my cabinet. But on receiving the memoir of my friend, Dr. Chapuis, suspecting that I might have made an error by neglecting to observe the antennæ in all directions, I relaxed some specimens, and was greatly pleased to find that the very extraordinary character upon which he had founded *Rhopalopleurus* really existed in my species. The other characters given in my detailed description above cited are, however, so characteristic, that the genus might have been recognized, without reference to the antennal funicle; a part of the body, which, as I have said above, I believe to be of but little value in the classification of these insects. Length 1.5 mm.; .06 inch.

2. **C. Chapuisii** n. sp.

Oval, robust, convex, black, with the antennæ testaceous, precisely as in *C. icoriæ*, and differing from it only by the interspaces of the elytra being densely clothed with small thick scales, and single rows of rather short bristles, and by the striæ being narrower and finely crenulate, instead of coarsely punctured. Length 1.5 mm.; .06 inch.

One ♂ Louisiana. The front is triangularly flattened and marked with a fine curved line, at the middle of which is a small transverse fovea.

POLYGRAPHUS Er.

In this genus the body is less robust, and of the usual cylindrical form, narrowed in front, and rounded behind, as seen in *Hylesinus*. The eyes

Digitized by Google

are divided, and the parts connected by a smooth corneous line. The scape of the antennæ is long and strongly clavate; the funicle is 5-jointed, the first joint stout, as long as the others united; 2–5 gradually increasing in thickness, short, closely united, forming a conical mass, to which the club is attached at the upper extremity of its base; the latter is strongly compressed, pubescent, and without sutures on both sides; oval-pointed, with the lower side less curved than the upper, and broader at the base than towards the tip, so as to be slightly securiform. The elytra are rugosely punctulate, scarcely striate, clothed with small stout scales, and with rows of scarcely longer erect bristles. The ventral segments are nearly equal, but the first and fifth are a little longer. The tibiæ are moderately dilated with three or four small teeth near the tip, which is obliquely truncate; the inner angle is slightly mucronate; the tarsi are slender, the third joint not emarginate, the fourth small but distinct, and the fifth as long as the others united, with divergent simple claws.

1. **P. rufipennis** Lec., Tr. Am. Ent. Soc 1868, 169; *Apate* (*Lepisomus*) *rufipennis* Kirby, Fauna Bor. Am. iv, 193, tab. 9, fig 2; *A.* (*L.*) *nigriceps* Kirby, ibid, 194, (immature); *P. saginatus* Mann., Bull. Mosc. 1853, 237; *Hylesinus rufipennis* Mann., ibid. 1853, 237.

New Hampshire to Alaska, also in Georgia. The surface of the elytra is slightly asperate near the base, which is very acutely margined; the rows of punctures which represent the striæ are less indistinct in some specimens than in others. The male has the front slightly impressed, with a small frontal tubercle sometimes divided into two. Length 2–2.5 mm.; .08–.10 inch.

In some specimens a few separate lenses are scattered along the line between the two parts into which the eyes are divided; in others these are entirely absent.

Apate (*Lepisomus*) *brevicornis* Kirby, loc. cit. 194, may belong to this genus, and would differ by the shorter antennæ with smaller club. The type is unfortunately in bad condition, and quite irrecognizable.

Group II. **Phlœotribi.**

This group is intermediate between the preceding and the following, and differs from both by the antennal club being composed of three separate joints, which in *Phlœotribus* form a lamellate mass, and in the European genus *Phlœophthorus* a loosely articulate club as in many Clavicornia. Dr. Chapuis describes the antennæ as frontal; but I see no special difference in their position from that observed in the preceding and following groups. The head is but very little prolonged in front of the eyes, and there is no preocular groove for the reception of the scape of the antennæ such as is observed in the two following groups. The tibiæ are dilated, compressed, obliquely rounded and serrate at tip, with the inner angle slightly mucronate; the tarsi have the joints 1–3 short, gradually a little wider; third not emarginate; fourth very small; fifth as long as the others united, with divergent simple claws. The basal margin of the elytra is acute and serrate.

Digitized by Google

But one genus is represented in our fauna:

PHLŒOTRIBUS Latr.

The eyes are transverse, oblique, and not emarginate. Two species are known to me; both clothed with stiff pubescence.

A. Lamellate joints of club very long; tibiæ finely serrate.

Elytra with striæ of large punctures, interspaces nearly flat, rugosely punctulate, sides and apex feebly serrate, prothorax finely punctulate...................... 1. **liminaris**.

B. Lamellate joints of club short, not more than twice as wide as long; tibiæ coarsely serrate.

Elytra with striæ of large punctures, interspaces narrow, serrate with single rows of small acute granules, sides and apex strongly serrate; prothorax finely not densely granulato-punctate.................................. 2. **frontalis**.

1. P. **liminaris** Lec., Tr. Am. Ent. Soc. 1868, 148; *Tomicus liminaris* Harris, Inj. Ins. ed. ult. 88.

Middle States, depredating on peach trees, and according to Miss Margaretta Morris (Downing's Horticulturalist, iv, 502), producing the disease called the yellows. Length 2.2 mm.; .85 inch.

2. P. **frontalis** Zimm., Tr. Am. Ent. Soc. 1868, 148; *Bostrichus fr.* Fabr., Syst. El. ii, 389; *Scolytus fr.* Oliv., Ins. No. 78, 13, Pl. 2. f. 20; *Phlœophthorus granicollis* Eichhoff, Berl. Ent. Zeitschr. 1868, 149; *Phlœotribus gr.* Chapuis, Mem. Soc. Roy. Sc. Liége.

♂. Head broadly concave, armed with a small erect acute spine each side above the insertion of the antennæ; the spines vary in length, according to the individual.

♀. Head nearly flat, with a faint crescentic impression.

District of Columbia, Georgia, Iowa; found in Missouri by Mr. Riley, depredating on mulberry. I have mentioned *Phlœotribus setulosus* and *dubius* Eichhoff, (Berl. Ent. Zeitschr. 1868, 149), as synonyms of this species; but from the memoir of Dr. Chapuis, above cited, I learn that these are really South American species. The locality given by Mr. Eichhoff is therefore incorrect, and his descriptions are so indefinite as to render my error quite excusable.

This species is of the same size and form as the preceding, but is readily recognized by the differences in the antennal club and in the sculpture of the prothorax and elytra.

Group III. Hylurgi.

In this group the form varies from oval to cylindrical; the antennæ are inserted at the sides of the front, immediately before the eyes, which are large, transverse, slightly or not at all emarginate, and finely granulated. The scape of the antennæ is long, and is received in a narrow, transverse groove in front of the eyes; this groove becomes more developed in the next

Digitized by Google

group, but is not apparent in the preceding groups or tribes; the mandibles are stronger, nearly flat above, and the labrum is obsolete; these characters indicate a recurrence towards the normal Rhynchophora. The funicle of the antennæ is 5–7-jointed; the first joint stout, the others slender, closely united; the club is very slightly compressed, annulated and pubescent, oval-pointed in *Hylesinus*, circular, compressed, nearly glabrous, with transverse sutures in *Dendroctonus*. The ventral segments are convex, nearly equal; the first and fifth somewhat longer, the sutures deep and straight. The tibiæ are dilated, and strongly toothed except in *Cnesimus*, where they are not serrate; the third joint of the tarsi is usually bilobed, and the fourth very small; the fifth long with divergent simple claws.

The basal margin of the elytra is elevated and acute as in the two preceding groups, and the prothorax is narrowed from the base forwards.

Funicle 7-jointed................................	2.
" 6-jointed................................	BLASTOPHAGUS.
" 5-jointed................................	4.
2. Tibiæ with few teeth; prothorax strigose longitudinally, anterior coxæ widely separated; club elongate-oval, compressed..........	CNESINUS.
Tibiæ serrate; club elongate-oval, pointed, not compressed..............................	HYLESINUS.
3. Club oval, obtusely pointed; first joint of tarsi not shorter; outer joints of funicle much broader.	PHLŒOSINUS.
Outer joints of funicle scarcely broader........	CHÆTOPHLŒUS.
Club oval-elongate; first joint of tarsi short....	CARPHOBORUS.
" circular, compressed; first joint of tarsi not shorter..................................	DENDROCTONUS.

CNESINUS Lec.

Nemophilus Chapuis.

I have already sufficiently described this remarkable genus, which is at once known by the widely separated front coxæ, and the longitudinally aciculate prothorax. Dr. Chapuis is in error in describing the tibiæ as "extus integerrimæ;" the front tibiæ have three acute teeth directed backwards, of which the third is apical, and the others near the apex; the outer apical angle of the middle tibiæ is produced, and emarginate at tip. The third joint of the tarsi is visible but not conspicuously emarginate; the joints 1–3 are rather stout, nearly equal, and the fifth is shorter than the others united.

1. **C. strigicollis** Lec., Tr. Am. Ent Soc. 1868, 171; *Nemophilus strigillatus* Chapuis, Mem. Soc. Roy. Sc. Liége, 1869, 27.

Illinois and South Carolina; also in Texas, according to Chapuis. Length 3 mm.; .11 inch.

HYLESINUS Fabr.

This genus represents the first division of my memoir, above cited, and contains those species in which the funicle is composed of seven distinct

Digitized by Google

joints, which united are nearly or quite as long as the club. The tibiæ are finely serrate at and near the tip; the joints 1–3 of the tarsi are rather broad and equal, the third bilobed; the fifth about equal to the others united, and clavate, with simple, divergent claws.

With one exception, the species are densely clothed with flat scales, and variegated in color with pale and dark gray tints.

Body oval, clothed with pale and dark scales, without intermixed hairs	2.
Body elongate..	4.
2. Club of antennæ elongate-fusiform, bands of elytra oblique.......................................	3.
Club of antennæ oval, body stouter, bands of elytra transverse....................................	3. **fasciatus.**
3. Sides of prothorax muricate before the middle......	1. **imperialis.**
" " not muricate....................	2. **aculeatus.**
4. Clothed with scales, with rows of bristles on the elytra	4. **sericeus.**
Clothed with short, erect yellow hair, without scales	5. **opaculus.**
Thinly and finely pubescent; prothorax muricate at the sides.......................................	6. **aspericollis.**

1. **H. imperialis** Eichhoff, Berl. Ent. Zeitschr. 1868, 149; Lec., Tr. Am. Ent. Soc. 1868, 169; *H. aculeatus* ‡ Chapuis, l. c. 32.

Dakota and Arizona. Resembles the next species, but is easily known by the muricate punctures of the sides of the prothorax; the basal edge of the elytra is also more strongly serrate. There is no such difference in the depth or punctuation of the elytral striæ as to warrant the differential phrases used by Dr. Chapuis. It is found also in Wisconsin and Georgia, according to Eichhoff, and seems to me to be barely distinct from the following species.

2. **H. aculeatus** Say, Journ. Ac. Nat. Sc. Phil. iii, 322; ed. Lec., ii, 181; Zimm., Tr. Am. Ent. Soc. 1868, 149; *H. pruinosus* Eichhoff, Berl. Ent. Zeitschr. 1868, 149; Chapuis, Mem. Soc. Roy. Sc. Liege, 1869, 32.

Massachusetts to Texas, Kansas and Oregon; depredates on *Fraxinus*. So far as the distinctions exist between this and the preceding, they are well exhibited in the descriptions of Eichhoff; to whom, however, the descriptions of Say seem to have been unknown. It has happened unfortunately that Dr. Chapuis has applied Say's name to the less known form called *imperialis* by Eichhoff, and retained *pruinosus* for the present well-known and widely diffused form.

The Munich Catalogue has added to the confusion by citing Say's description under the genus *Dendrosinus* (2673), and placing *H. globosus* Eichhoff, as a synonym. The latter is probably a South American species, described by Eichhoff, with an incorrect locality, since a variety of it is mentioned by Chapuis (p. 28) as occurring in Columbia. Length 2.2–3.4mm.; .09–.13 inch.

In the ♂ the head is more flattened than in the ♀; and occasionally

Digitized by Google

has a very narrow smooth longitudinal line. The specific name is badly chosen, as it is only in partially abraded specimens that the muricate punctures of the interspaces of the elytra can be seen.

3. **H. fasciatus** Lec., Tr. Am. Ent. Soc. 1868, 170.

One specimen, York county, Pa. A small species of stouter oval form, with the club of the antennæ thicker, less elongate, and corneous and shining at the base. Length 1.5 mm.; .06 inch.

4. **H. sericeus** Mann., Bull. Mosc. 1852, 385; *Hylurgus ser.* Mann., ibid, 1843, 296; ibid, 1852, 356.

Var. *H. nebulosus* Lec., Proc. Ac. Nat. Sc. Phil. 1859, 285.

Alaska to California. Length 3 mm.; .12 inch. The outer interspaces of the elytra are marked with a row of small acute tubercles. The bristles of the elytra are longer in the type than in the variety, and the sides of the prothorax seem a little more rounded, but otherwise there is no special difference. The elytra are not banded as in the preceding species, but confusedly tesselated. I observe no sexual characters, and the front is finely carinate in the four specimens examined. The head is more prolonged than in the other species. The club of the antennæ is subovate pointed, about twice as long as wide, annulated with straight sutures.

5. **H. opaculus** Lec., Tr. Am Ent. Soc. 1868, 170; *Phlœosinus* ‡ *liminaris* ‡ Chapuis, Mem. Soc. Roy. Sc. Liége, 1869, 39.

Middle States. This species has a deceptive resemblance to *Phlœotribus frontalis*, and it is only by examining the antennæ that it may with certainty be separated. The reference to the genus *Phlœosinus* is incorrect, as the outer part of the funicle is divided into six joints by five transverse sutures, precisely as in the other species of *Hylesinus*. The club is subovate, obtusely pointed, with straight sutures, and the basal part is more shining and less pubescent than usual. Length 2–2.5 mm.; .08–.10 inch.

6. **H. aspericollis** n. sp.

Cylindrical, rather elongate, blackish-brown, thinly clothed with fine short pubescence. Head sparsely punctured, with a faint frontal impression, and an indistinct smooth median line. Prothorax at base scarcely wider than long, slightly rounded on the sides, gradually narrowed in front, but not constricted, nearly truncate at base and apex, finely and densely punctured, sparsely but strongly asperate, with acute tubercles at the sides. Elytra with punctured striæ, interspaces moderately convex, granulato-rugose, and muricate with acute small spines becoming more prominent on the declivity. Antennæ ferruginous, with seven distinct joints in the funicle; club oval-pointed, transversely annulated as usual; front tibiæ rather suddenly dilated at the tip. Length 2.5–3.4 mm.; .10–.13 inch.

California, (at Santa Barbara?); Mr. Crotch; several specimens, in which I observe no special sexual differences, except that in some the frontal impression is a little deeper. It is similar in form to *H. opaculus* but larger, with the pubescence much finer and inconspicuous.

Digitized by Google

PHLŒOSINUS Eichhoff.

In this genus the funicle of the antennæ is much shorter than the club, the first joint is rounded, the remaining four joints are closely united and gradually become broader; the club is large, oval, compressed, obtusely rounded, and divided by straight well-marked sutures. The front coxæ are moderately distant. The tibiæ are acutely serrate; the tarsi have the joints 1–3 equal, the third bilobed; the fifth is nearly equal to the others united. I have erroneously mentioned the funicle of the antennæ of these species as 6-jointed, in the memoir cited below.

Pubescence fine, sparse, declivity of elytra with first and third interspaces more elevated, and more strongly tuberculate..........................	1. **serratus.**
Pubescence fine, sparse, declivity of elytra with third interspace elevated behind....	2. **cristatus.**
Pubescence fine, less sparse, declivity of elytra more finely tuberculate, or serrate, nearly equal in convexity..	3. **dentatus.**
Pubescence fine, less sparse, striæ of elytra strongly punctured, second interspace depressed on the declivity, the others serrate with acute tubercles, nearly equal in convexity........................	4. **punctatus.**

1. **P. serratus** Lec., Tr. Am. Ent. Soc. 1868, 170.

New York, one specimen. This species is cited in the Munich Catalogue as undescribed. The diagnosis given on page 169 of my memoir, and the explanatory remarks under the next species contain all the information necessary to distinguish it from the common and well known *P. dentatus*. Any lengthy description would be unnecessary, as it only differs by larger size, and by the first and third interspaces being strongly elevated and serrate behind. The pubescence is shorter, and seems less dense than in *P. dentatus*, but this may be produced by abrasion. Length 3.5 mm.; .14 inch.

The striæ are distinctly punctured; the interspaces wide, densely and strongly granulate and rugose. The front is very slightly carinate.

2. **P. cristatus** Lec., Tr. Am. Ent. Soc. 1868, 170.

California; cabinet of Mr. Ulke. I have no specimen of this species, and can only say that it differs from the preceding by the larger size (4 mm.; .16 inch); and by the sutural interspace being less elevated than the third, though also serrate.

3. **P. dentatus.** *Hylurgus dent.* Say, Journ. Acad. Nat. Sc. Phil. v, 258; ed. Lec., ii, 319.

Middle and Eastern States and Canada; depredates on *Juniperus*. Smaller than the two preceding, with the declivity of the elytra more abrupt and flattened, and less convex; the striæ are impressed and scarcely punctured, the interspaces are wide, densely and strongly granulate and rugose; the rugosities becoming acute tubercles on the declivity of the alternate interspaces; second interspace not depressed on the declivity, and furnished

Digitized by Google

with a row of smaller tubercles in some specimens, but not in others. This difference is probably sexual. The head is granulato-punctate, and the front is not carinate.

4. P. **punctatus**, n. sp.

This species precisely resembles *P. dentatus* in form, size and sculpture, except that the striæ of the elytra are wider, and strongly punctured; the interspaces narrower, less densely granulated and rugose, and the second interspace on the declivity is depressed, shining, sparsely punctured, and narrower than the adjacent interspaces. The front is finely but distinctly carinate. Length 2 mm.; .08 inch.

Oregon and Lake Superior.

P. **Haagii** Chapuis, Mem. Soc. Roy. Sc. Liege, 1869, 38; *Dendroctonus Haagii* Eichhoff, Berl. Ent. Zeitschr. 1868, 148, may be synonymous with this species, but I do not observe in the four specimens in my collection any trace of the smooth dorsal line extending from the base beyond the middle, as mentioned in Chapuis' description. Neither is the locality given, "Amer. bor.," of much service in identifying the species in a genus where the forms are so closely similar.

P. **graniger** Chapuis, l. c. 39, I am also unwilling to attach as a synonym to any of the species above described; being from Texas it is quite likely to be different. The descriptions of both these species will be found in the appendix.

CHÆTOPHLŒUS n. g.

This genus is founded upon *Hylesinus hystrix*, a singular species from California, of robust oval form, thickly clothed with coarse, erect hair. It differs from *Phlœosinus* by the four joints which constitute the outer part of the funicle of the antennæ being slender, and increasing much less rapidly in thickness; the club is equally large, subovate, compressed, obtusely rounded at tip, and the sutures are also straight. The mouth is clothed with long, coarse hair. The prosternum is very short in front of the coxæ, which are very narrowly separated. The first ventral segment is longer than the second, and the third, fourth and fifth are short. The tibiæ are broadly dilated, rounded and finely serrate at tip; the tarsi are not plainly visible in the unique specimen in my collection, but the third joint is emarginate, rather than bilobed.

1. C. **hystrix** Lec., Pr. Ac. Nat. Sc. Phil. 1858, 81; Tr. Am. Ent. Soc. 1868, 171 (*Hylesinus*).

San Diego, one specimen. The head is broadly concave, with a smooth medial line. The prothorax is strongly and densely punctured. The elytral striæ are not impressed, and are composed of approximate punctures; the interspaces are flat, punctured; the declivity is rounded, the part near the suture is deeply and broadly concave, and the outer side of the concavity, corresponding to about the fourth interspace, is armed with four or five tubercles; the sutural interspace on the declivity is narrow, slightly elevated, and marked with a row of very small granules. Length 2.2 mm.; .09 inch.

Digitized by Google

CARPHOBORUS Eichhoff.

This genus contains species of small size and elongate form; dull, densely punctured surface, clothed with very small yellowish scales. The elytra are striate with large, approximate punctures; the second interspace is narrowed and abbreviated on the declivity, and the third is elevated into a high, spinulose crest, which unites with the apical margin; this margin is similarly thickened and elevated, though to a less extent. The funicle of the antennæ is 5-jointed; first joint larger and rounded, the others closely united, forming a short, conical mass, as in *Phlæosinus*; club large, slightly pubescent, moderately compressed; rounded, obtuse at tip, and divided by two straight sutures; the first joint of the club is more shining than the others. Prosternum very short in front of the coxæ, which are large, prominent and contiguous. The tibiæ are moderately dilated, the front ones have two acute teeth near the tip, on the outer side, and a long, terminal hook at the inner angle; the other tibiæ are obliquely rounded at tip and finely serrate; the first joint of the tarsi is shorter than the second; the third is equal to the second, not bilobed; the fifth is as long as the others united. The mouth is clothed with long, coarse hair as in *Chætophlæus*.

First and third interspaces of the elytra elevated on the declivity and serrate........................ 2.
First and third interspaces scarcely elevated, not serrate.. 1. **simplex.**
2. First and third moderately elevated; second not much narrowed on the declivity...................... 2. **bifurcus.**
First and third strongly elevated; second much narrower on the declivity......................... 3. **bicristatus.**

1. **C. simplex** n. sp.

Elongate-cylindrical, blackish-brown, somewhat shining. Head finely and densely granulato-punctate in front, nearly smooth behind. Prothorax twice as wide as long, broadly rounded on the sides, narrowed and feebly constricted in front, which is nearly truncate; base slightly bisinuate; finely punctured, with a faint indication of a smooth dorsal line; scarcely perceptibly pubescent. Elytra with striæ of quadrate punctures, interspaces finely roughened, thinly clothed with very small scales, second interspace depressed and narrowed on the declivity, first and third slightly elevated, not serrate. Length 2.2 mm.; .085 inch.

♂. Head with a round excavation fringed with long yellow hairs.

♀. Head slightly impressed, not hairy.

Mojave Desert, California; Mr. Crotch. The fifth joint of the funicle is broader and almost part of the club; the third joint of the tarsi is not wider than the second, just as in the other species.

2. **C. bifurcus** Eichhoff, Berl. Ent. Zeitschr. 1868, 147; *Dendroctonus bif.* Zimm., Tr. Am. Ent. Soc. 1868, 148; Chapuis, Mem. Soc. Roy. Sc. Liége, 1869, 97.

♂. Front with two small approximate tubercles.

♀. Front uniformly convex.

Digitized by Google

District of Columbia; Ulke. This species differs from the next by the third interspace of the elytra being less elevated on the declivity, and the second less evidently narrowed. The punctures of the elytral striæ are also larger. A greater number of specimens will probably show that these differences are not of specific value. Length 1.5 mm.; .06 inch.

3. **C. bicristatus** Chapuis, loc. cit. 97.

Georgia, two females; under pine bark. Length 1.8 mm.; .07 inch.

DENDROCTONUS Er.

The body is stout cylindrical, narrowed in front, punctured and hairy; the funicle is 5-jointed, the first joint rounded, but not large; the other joints gradually increasing in breadth; club rounded, strongly compressed, scarcely pubescent, divided by three transverse straight sutures. Prothorax slightly emarginate in front, bisinuate at base. Prosternum not very short in front of the coxæ, broadly concave, with traces of a ridge each side, as in *Phlœosinus* and *Blastophagus;* front coxæ contiguous. Tibiæ moderately dilated, with a few large lateral and apical teeth; terminal spine stout and straight; tarsi with joints 1–3 slightly decreasing in length; third wider, deeply bilobed, fourth small, distinct; fifth as long as the others united. Ventral segments nearly equal in length; the first suture is straight, the others strongly curved backwards at the side.

The species depredate upon pine trees, and are closely allied and difficult to distinguish; the dorsal line of the prothorax varies in individuals of the same species; I cannot change the table I have given in the memoir cited below except by adding one new species.

Prothorax narrowed in front, slightly bisinuate at base .... 2.
" very slightly narrowed in front, strongly bisinuate at base; head large .... **7. frontalis.**
2. Interspaces rough both on the disc and on the declivity .... 3.
Interspaces rough towards the base, but only punctured on the declivity .... 4.
3. Prothorax very densely coarsely punctured; hairs of elytra not very long .... **1. terebrans.**
Prothorax less densely punctured; hairs of elytra long .... **2. similis.**
4. Prothorax punctured with smaller punctures intermixed, hairs of elytra long .... **3. rufipennis.**
Prothorax equably punctured, occiput finely punctured, hairs of elytra long .... **4. punctatus.**
Prothorax equably punctured, occiput sparsely punctured, hairs of elytra long; smaller, with broader prothorax .... **5. simplex.**
Prothorax finely sparsely punctured; elytra opaque, densely, finely granulated and punctulate, pubescence very short .... **6. brevicomis.**

Digitized by Google

1. **D. terebrans** Lac., Gen. Col. vii, 361; Zimm., Tr. Am. Ent. Soc. 1868, 149; *Scolytus ter.* Oliv., Ent. 78, p. 6; pl. 1. f. 6; *D. valens* Lec., Pacific R. R. Expl. and Surveys, Ins. 59; Chapuis, Mem., Soc. Roy. Liége, 1869, 91.

Canada, Georgia, Oregon, California. The specimens from the Pacific slope are larger, and the punctures of the prothorax are rather smaller and more dense, but these differences do not seem to me worthy of specific distinction. Some specimens from New Hampshire and Canada have the prothorax more sparsely punctured, almost as in the next species, from which they are only distinguished by the shorter hairs of the elytra. Length 5.2–8 mm.; .2–.32 inch.

2. **D. similis** Lec., Pac. R. R. Expl. and Surveys, Ins. 59.

Oregon; five specimens. I have incorrectly cited this species as a synonym of *D. obesus*, from which it differs in having the asperities of the elytra continue on the declivity. The tibiæ are armed, as in the preceding, with three acute teeth on the outer side near the tip, but the prothorax is less densely punctured, and the elytral hairs are longer; the back part of the head is less densely punctured. Length 4.5–6.5 mm.; .18–.25 inch.

A smaller and somewhat more elongate form occurs in Canada, Texas and Colorado, but I do not think it capable of being separated as a distinct species. Length 4.2 mm.; .165 inch.

3. **D. rufipennis** Kirby, Fauna Bor. Am. iv, 195, (*Hylurgus*); Mann., Bull. Mosc. 1853, 238; *Hylurgus obesus* Mann., ibid. 1843, 296; ibid. 1852, 356.

Alaska, Canada, Anticosti. I can perceive no difference between the specimens sent me under the names cited above. It is only to be distinguished from the preceding by the declivity of the elytra smoother and more shining, and almost without asperities; and by a slight difference in the punctures of the prothorax, which are of unequal size. The dorsal line of the prothorax is sometimes narrow and elevated, sometimes obsolete. Length 6 mm.; .24 inch.

4. **D. punctatus** Lec., Tr. Am. Ent. Soc. 1868, 193.

New York; three specimens. Very similar to the preceding, but the back part of the head is nearly smooth, or feebly punctulate; the punctures of the prothorax are larger and less dense, and the declivity of the elytra less shining, and very slightly asperate. Length 6 mm.; .25 inch.

5. **D. simplex** Lec., Tr. Am. Ent. Soc. 1868, 173.

Canada; two specimens. Much smaller, with the prothorax comparatively wider and shorter, and more densely punctured. The elytra are more shining, and more strongly and sparsely punctured on the declivity; the head is sparsely but deeply punctured behind, and in front is densely granulate as usual. Length 4 mm.; .16 inch.

If I have failed to indicate more strongly the differences between these species, it is because they are not distinguished by any prominent or definite characters; and the student, who may have difficulty in identi-

Digitized by Google

fying the species as here defined, would have almost equal difficulty, if the specimens in my collection were before him.

6. **D. brevicomis**, n. sp.

Elongate-cylindrical, red-brown, with a few long hairs on the prothorax, and numerous very short ones on the elytra. Head large, finely not densely granulate, rugose, occiput nearly smooth, face with an interrupted longitudinal impression, antennæ with circular compressed club, sutures transverse, funicle 5-jointed. Prothorax at base nearly twice as wide as long, as strongly bisinuate as in *D. frontalis;* very slightly narrowed towards the tip, and slightly constricted; punctures small, not dense, surface shining, with no trace of a dorsal line. Elytra opaque, striæ indistinct, composed of not very evident punctures; surface finely densely granulate, becoming punctulate on the declivity; in other respects it resembles the other species of the genus. Length 4.2 mm.; .17 inch.

One specimen; Middle California. Intermediate in form of prothorax between the next and the foregoing species, but strikingly different from both by the sculpture and pubescence of the elytra.

7. **D. frontalis** Zimm., Tr. Am. Ent. Soc. 1868, 149; (synon. excl).

Lake Superior to Georgia. The head is channeled and marked with approximate frontal tubercles; the occiput is finely punctulate, the front roughly punctured as usual. The interspaces of the declivity of the elytra are finely asperate, and the hairs are short. The prothorax is scarcely narrowed in front, and the base is more strongly bisinuate than in the other species. The club of the antennæ is round, strongly compressed and concave on one side, as in the other species; and the sutures are not straight, but curved. Length 3 mm.; .12 inch.

The frontal channel is deeper, and the granulate punctures larger, and denser in one sex than in the other.

Dr. Zimmermann cites as a synonym *Bostrichus frontalis* Fabr., Syst. El. ii, 389; the description appears to me not to correspond, and I have cited it above as pertaining to *Phlœotribus frontalis*, (p. 377).

BLASTOPHAGUS Eichhoff.

This genus does not properly belong to our fauna, and I mention it only for the purpose of correcting the error, which I committed of describing an accidentally introduced specimen of the common European *B. piniperda* under the name *Hylurgus analogus*, Tr. Am. Ent. Soc. 1868, 172. The last mentioned name must therefore be erased from our list. I also compared it with the European *H. ligniperda* on the authority of an incorrectly named specimen which I borrowed for comparison. If the genus should hereafter occur in our fauna, it can be easily recognized by the outer part of the funicle of the antennæ being divided into 5 joints, thus making the funicle 6-jointed, and by the club being ovate-pointed, not compressed, transversely annulated, with the joints smooth and shining, fringed with hairs. The beak is somewhat more distinctly developed than in *Dendroctonus*, and the antennal grooves are wider and deeper.

Digitized by Google

Group IV. **Crypturgi.**

This group consists of two genera, represented by very small species of elongate form, which agree with *Hylastes* in general appearance and sculpture, but differ by the beak being much shorter, and the prosternum very short and not excavated. The genus *Crypturgus* has been usually associated with the *Tomicini*, on account of the slender tarsi, but it makes a notable exception to the other members of that tribe by the large exserted head, and the absence of the hood-like prolongation of the prothorax. I have, therefore, thought it best to remove it from that position, and place it with *Dolurgus*, as a separate group. Though differing in the antennal club, which is solid in *Crypturgus*, and annulated transversely with the first joint corneous in *Dolurgus*, these two genera are otherwise closely related, and differ remarkably from neighboring forms by the small number of joints in the funicle. The prothorax is elongate-oval, rounded in front, nearly truncate at base; the scutellum is very small, not depressed, and the basal edge of the elytra is not elevated. The elytra are elongate-cylindrical, with the posterior declivity convex; the striæ are well marked, and strongly punctured; the interspaces narrow, finely punctulate and slightly pubescent. The ventral sutures are straight and deep; the first and fifth segments are longer than the others. The prosternum is very short, not excavated; the front coxæ are contiguous; the tibiæ are dilated, and finely serrate; the terminal spur is very small; the tarsi are slender, with the third joint not dilated.

Antennal club solid; funicle 2-jointed............... CRYPTURGUS.
" " annulated; funicle 3-jointed.......... DOLURGUS.

CRYPTURGUS Er.

1. **C. atomus** Lec., Tr. Am. Ent. Soc. 1868, 152.

Canada, Massachusetts, New York; under bark of dead pine branches. Length 1 mm.; .04 inch.

DOLURGUS Eichhoff.

1 **D. pumilus** Eichh., Berl. Ent. Zeitschr. 1868, 147; Chapuis, Mem. Soc Roy. Sc. Liége, 1869, 80; *Hylastes pumilus* Mann., Bull. Mosc. 1843, 297; ibid. 1852, 356; *Aphanarthrum* ‡ *pum.* Lec., Tr. Am. Ent. Soc. 1868, 152.

Alaska. Examination of specimens of *Aphanarthrum* subsequently obtained, shows that my reference of this species to that Madeiran genus was incorrect; there is no resemblance between them, except in the form and number of joints of the antennæ. Eichhoff describes the funicle as 4-jointed, but the error is corrected by Chapuis. Length 1.8 mm.; .07 inch.

Group V. **Hylastes.**

In this group a reversion is made towards *Cossonidæ* and some tribes of *Curculionidæ*, in the antennal funicle and club, the excavated prosternum, and the antennal grooves of the beak, which, though short and stout, is more developed than in any other *Scolytidæ*. The tibiæ are, however,

Digitized by Google

more strongly serrate, and are armed with a strong apical spur; the tarsi are rather short, and the third joint is more or less dilated, bilobed or emarginate. The ventral sutures are straight and deep; first and fifth segments longer than the others. The head is exserted and prominent, the beak short and stout, with oblique deep grooves, which unite in the gular space, forming a transverse impression; the eyes are transverse, not very finely granulated. Antennæ with 7-jointed funicle and oval annulated club, which is not compressed, and has the basal joint large, corneous and shining, very much as in *Baris*. The scutellum is small, not depressed, and the basal margin of the elytra is not acutely elevated, though quite distinct in *H. granulatus* and *pinifex*.

Three genera are indicated by our species:

Front coxæ contiguous, or nearly so................	2.
" " widely separated......................	**SCIERUS.**
Third joint of tarsi emarginate.....................	**HYLASTES.**
" " " bilobed..........................	**HYLURGOPS.**

HYLASTES Er.

I have but two species to add to those mentioned in my synopsis, which may be thus tabulated; all have the third joint of tarsi emarginate, not dilated; mesosternum truncate, not protuberant; tibiæ with very large teeth; prosternal ridges acute; basal margin of elytra not acute.

	Beak carinated....................................	2.
	Beak not carinated; small, slender, dark brown, elytra coarsely punctured in rows, with rows of short suberect hairs..................................	8.
2.	Glabrous or subglabrous species	3.
	More or less hairy...............................	7.
3.	Elytral interspaces not convex, punctured and less rugose; form more slender, prothorax more densely punctured........	4.
	Elytral interspaces convex, rough and rugose...	6.
4.	Longer and narrower than *nigrinus* and more finely sculptured on the head and prothorax...........	5.
	Somewhat less slender, more coarsely sculptured.....	3. **nigrinus.**
5.	Prothorax nearly elliptical, more coarsely punctured	1. **macer.**
	Prothorax gradually narrowed in front, less coarsely punctured..................................	2. **longus.**
6.	Elytra rougher, and muricate behind towards the sides	4. **porculus.**
	Rugosities finer, sides of elytra not muricate...	5. **cavernosus.**
7.	Pubescence fine and short; prothorax equably punctured...........	6. **gracilis.**
	Hairs long and sparse; prothorax coarsely punctured, with smaller punctures intermixed..............	7. **porosus.**
8.	Interspaces of elytra opaque, rough with small granules	8. **tenuis.**
	Interspaces of elytra somewhat shining, rugose......	9. **exilis.**

Digitized by Google

2. H. longus, n. sp.

Slender, cylindrical, black, nearly glabrous. Head densely punctured, beak finely carinate, front with a transverse impression. Prothorax longer than wide, base and hind angles rounded, sides slightly rounded, converging gradually to the tip, which is broadly rounded; punctures deep and strong, larger at the base than at the tip and sides, where they are also more dense; no smooth dorsal line is visible. Elytra less shining than the prothorax, with striæ composed of moderate sized punctures; interspaces nearly flat, wider than the striæ, densely, finely punctured. Club of antennæ brown, first joint composing about one-half of the mass. Length 4.5 mm.; .175 inch.

Colorado, Prof. F. H. Snow; one specimen. This species resembles closely *H. macer*, but can be easily recognized by the different form of the prothorax.

The following synonyms will complete the bibliography I have already given in my synopsis.

4. **H. porculus** Er. Wiegm. Archiv. 1836, i, 49; *H. carbonarius* Fitch, Noxious Ins. New York, 4th report, No. 249; *H. granosus* Chapuis, Mem. Soc. Roy. Sc. Liége, 1869, 73; *H. scabripennis* Zimm., Tr. Am. Ent. Soc. 1868, 149; ? *H. salebrosus* Eichhoff, Berl. Ent. Zeitschr. 1868, 146.

5. **H. cavernosus** Zimm., l. c. 149; ? *H. scobinosus* Eichhoff, Berl. Ent. Zeitschr. 1868, 146; Chapuis, l. c. 78.

Eichhoff gives Carolina as the locality; Chapuis mentions Norfolk Sound, which, being on the Pacific coast, makes the reference doubtful. Perhaps the specimen came from Norfolk, Virginia, instead of Norfolk Sound. Should they prove to be the same, the name proposed by Eichhoff has priority by a few weeks.

9. **H. exilis** Chapuis, l. c. 20.

Florida, one specimen, Messrs. Hubbard and Schwarz. Nearly related to *H. tenuis*, but the prothorax is more coarsely punctured, and the interspaces of the elytra are not granulate, but rugosely punctured, and less opaque. Length 2.5 mm.; .10 inch.

HYLURGOPS n. g.

I have separated as a distinct genus the species referred to Erichson's second division, having the third tarsal joint broader and bilobed, and the mesosternum protuberant. They are quite different in form from true *Hylastes*, and resemble *Dendroctonus*, the prothorax being more narrowed forwards, and more finely and densely punctured. The basal margin of the elytra is so acutely defined in *H. granulatus* and *pinifex* that I should place them near *Hylurgus*, but for the scutellum, which is not depressed; and for the deeper antennal grooves, which remove them from the group of *Hylurgi*. The front tibiæ are less coarsely serrate than in *Hylastes*.

The species may be thus distinguished:

Prosternal ridges acute; front transversely impressed. 2.

Digitized by Google

Prosternal ridges indistinct; beak carinate, front not impressed; color brown, elytra variegated with spots of pale scales, basal margin acute, subserrate .... **1. granulatus.**

2. Beak carinate; basal margin of elytra subacute, subserrate .... **2. pinifex.**

Beak not carinate; basal margin of elytra subacute, subserrate .... **3. rugipennis.**

Beak not carinate; basal margin of elytra acute, serrate; alternate interspaces more elevated behind .... **4. subcostulatus.**

1. H. **granulatus** Lec., Tr. Am. Ent. Soc. 1868, 175 (*Hylastes*).

Oregon and California. The variegated spots of the elytra are formed of small pale scales, and were not apparent in the two specimens upon which my description was based. Length 5 mm.; .20 inch.

2. H. **pinifex** Fitch, Noxious Ins. New York, 4th report, 43, No. 248; (*Hylastes*); Lec., Tr. Am. Ent. Soc. 1868, 176.

Lake Superior, Canada, Ohio. Length 5 mm.; .20 inch.

3. H. **rugipennis** Mann., Bull. Mosc. 1843, 297 (*Hylurgus*); ibid, 1853, 238 (*Hylastes*); Lec., loc. cit. 176; Chapuis, l. c. 76.

Alaska, Oregon and California. Length 4–4.5 mm.; .16–.18 inch.

4. H. **subcostulatus** Mann., Bull. Mosc. 1853, 239.

Oregon and Sierra Nevada; described by Mannerheim from Alaska. Length 4 mm.; .16 inch.

Hylastes **rufipes** Eichhoff, Berl. Ent. Zeitschr. 1868, 147; Chapuis, l. c. 79, probably belongs to this genus, but is unknown to me.

Hylastes **cristatus** Mann., Bull. Mosc. 1853, 239, from Alaska, may also belong here, but is unknown to me.

SCIERUS n. g.

I have separated under this generic name a species which agrees in general form with *Hylurgops*, but differs from it and *Hylastes* by the front coxæ being widely separated by the prosternum. The form of the third joint of the tarsi is intermediate, it being not as deeply bilobed as in *Hylurgops*, but broader than in *Hylastes*. It agrees with both in the antennæ, which have the funicle 7-jointed, and the club ovate-pointed, with the first joint smooth, shining, and nearly as long as the others united. The tibiæ are dilated and broadly serrate as in *Hylastes*; the terminal mucro is short. The first and second ventral segments are equal, and the third and fourth are shorter; the fifth is as long as the second. The other characters are those of the tribe, and it is not necessary to repeat them.

1. S. **annectens**, n. sp.

Oblong-cylindrical, dark brown, opaque, thinly clothed with very short depressed yellow hairs. Beak flat, punctured and hairy, about twice

Digitized by Google

as wide as long, not impressed or carinate; head convex, punctures becoming finer and obsolete on the occiput. Prothorax one-third wider than long, rounded on the sides, narrowed in front, faintly impressed but not constricted on the sides, nearly truncate in front and at base; densely and strongly punctured with a narrow dorsal line, which is obsolete in some specimens. Scutellum rounded behind, not depressed. Elytra wider than the prothorax; basal margin rather acute, finely serrate; striæ deeply impressed, punctured; interspaces wider than the striæ, scabrous with transverse rugosities, becoming asperate on the sides towards the tip; the interspaces become more convex on the declivity, and the third and ninth unite near the tip, and then join the first so that the second is a little shortened. Beneath coarsely and sparsely punctured and pubescent, and less opaque; legs lighter brown. Length 3.6 mm.; .14 inch.

Anticosti Island, Gulf of St. Lawrence, W. Couper; British Columbia and Vancouver Island, G. R. Crotch. No sexual difference observed.

Family X. ANTHRIBIDÆ.

Mentum large, deeply emarginate in front, closely connate, (except in the group *Hormisci,*) with the gular peduncle, which is broad and short; buccal fissures consequently narrow, only partially exposing the base of the maxillæ; ligula large, corneous, narrowly emarginate at tip; palpi 3 jointed, inserted at the sides of the lower face of the ligula, distant, slender, cylindrical, longer than in other Rhynchophora and flexible, as in normal *Coleoptera* and in *Rhinomaceridæ*; last joint elongated, narrower at the tip.

Maxillæ visible in the narrow buccal fissures, with two narrow lobes, usually rounded and ciliate at tip; palpi slender, 4-jointed, with the last joint longer and narrower at the tip.

Mandibles flattened on the upper surface, curved, pointed or emarginate at tip.

Antennæ inserted usually under the sides of the front, rarely upon the front. They are 11-jointed, slender and not geniculate; the first joint is stouter, but scarcely longer than the second; joints 3–8 slender, pubescent; 9–11 broader, more or less compressed, finely pubescent and sensitive. The antennæ of the ♂ are sometimes much longer than the body. The outer joints form a compact oval club in *Hormiscus*.

Head prominent, not deflexed; beak broad, flat, sometimes so short as to be indistinct; never cylindrical or slender, and never separated from the front by a transverse impression. Eyes moderate in size, not very finely granulated, rounded, sometimes slightly emarginate in front. Labrum distinct, quadrate, fringed with hairs. Gular suture completely obliterated.

Prothorax of varied form, usually trapezoidal and truncate in front; rarely somewhat rounded over the head (*Choragus*); base truncate, with a transverse, elevated line which is either antebasal (*Tropiderini*) or entirely basal; this line is abruptly bent forwards at the sides, and forms a more or less abbreviated side margin.

Digitized by Google

The prosternal sutures are entirely obliterated, as is also the short suture behind the posterior point of the prosternum, so that the under surface consists of but one piece. The coxal cavities are rounded, and narrowly separated.

Mesosternum flat, triangular behind, with the point rounded, and separating the middle coxæ; cavities rounded, epimera transverse, oblique, not attaining the coxæ.

Metasternum long, side pieces narrow, or moderate in width, wider in front, with the outer angle prolonged forwards; in many genera there is a transverse impression in front, simulating a suture.

Elytra conjointly rounded behind, and forming a small sutural fold, which fits into a deep emargination of the pygidium ; fold of the inner surface acute, not prolonged much behind the middle. Epipleuræ distinct. The striæ are ten in number, with a short scutellar one as in *Carabidæ*; this scutellar stria is usually about one-fourth the length of the elytra, and does not connect itself with the sutural stria.

Abdomen with five free, and sometimes nearly equal ventral segments; sutures straight; intercoxal process triangular, acute or rounded in front; dorsal segment membranous, except the pygidium, which is corneous, declivous and exposed ; no anal segment in the ♂.

Anterior coxæ narrowly separated, globose; middle coxæ moderately separated, rounded; hind coxæ transverse, not prominent, never very widely separated.

Legs slender, front pair sometimes elongated in ♂; tibiæ truncate at tip, without spurs or hooks.

Tarsi brush-like beneath, 4-jointed; second joint triangular, emarginate; third joint bilobed, sometimes large, sometimes small; fourth joint slender with divergent claws, which are either simple or toothed.

Our genera represent four tribes:

Antennæ inserted at the sides of the beak;
 Prothoracic ridge not basal........................ TROPIDERINI.
 Prothoracic ridge basal........................... BASITROPINI.
Antennæ inserted on the front; prothoracic ridge basal;
 Elytra striate as usual.......................... ARÆOCERINI.
 Elytra not striate............................... XENORCHESTINI.

Tribe I. TROPIDERINI.

The genera of this tribe are sufficiently distinguished by the position and form of the prothoracic ridge, which is remote from the base, more or less sinuous, and flexed obliquely at the sides. The antennæ are situated under the lateral edge of the beak, which is sometimes flattened and expanded so that the antennal cavities are partially covered.

Three groups occur in our fauna:

Eyes entire, suture of mentum obliterated........ 2.
 " emarginate; suture of mentum distinct............. Hormisci.

2. Sides of beak not dilated; antennæ very long............ **Ischnoceri.**
" " dilated over the antennal cavities.......... **Tropideres.**

Group I. **Ischnoceri.**

Beak longer than the head, dilated at tip; antennal cavities large, lateral, limited above by a small, elevated line, which descends to the inferior margin of the eyes. Eyes longitudinal, elliptical, rather coarsely granulated. Antennæ very slender, longer than the body in ♂; two-thirds as long in ♀; first joint very short; second twice as long as first, and more than one-half as long as third; 9–11 broader, forming a compressed, loose, oval club. Tarsi with the first joint long; second triangular, emarginate, with prolonged angles; third as wide as the second, bilobed; claws armed with a long, acute tooth at the middle.

ISCHNOCERUS Schönh.

1. I. **infuscatus** Fahraeus, Sch. Curc. v, 192; *Meconemus tuberculatus* Imhoff and Labram, Gen. Curc. 1, 40.

Mexico, extending into the Southern States as far as South Carolina. In the Mexican specimens the pubescence is somewhat paler and more dense; it is *Ischnocerus macrocerus* of Dejean's Catalogue.

This is a narrow species, with the base of the prothorax truncate; there is a trace of a second transverse raised line between the base and the antebasal ridge; the latter is situated about one-fifth from the base, slightly sinuate, and forming an obtuse angle at the middle; flexed obliquely forwards on the side, where a distinct lateral angle is formed behind the middle. The pubescence is yellowish brown, mixed with pale gray, and does not exhibit any distinct pattern. Length 6.8–10 mm.; .27–.40 inch.

Group. II. **Tropideres.**

The sides of the beak in the insects of this group are dilated over the antennal cavities, which are therefore not visible from above. The form of the antebasal ridge differs in each genus, and in conjunction with the antennal club and tarsal claws affords easy characters for distinguishing the genera. The eyes are entire, either rounded or oblique.

Antennal club narrow, not compressed........... 2.
" " oval, compressed.................. 3.
2. Prothoracic ridge strongly angulated and touching the base at the middle; claws simple.......... GONOTROPIS.
Prothoracic ridge straight at the middle, base deeply biemarginate; claws acutely toothed.......... EURYMYCTER.
3. Eyes oblique, slightly oval, beak short............ TROPIDERES.
Eyes rounded, beak longer, antennæ ♂ very long.. ALLANDRUS.

GONOTROPIS n. g.

Body rather robust and convex. Beak longer than the head, gradually narrowed to the middle, then widened to the tip, which is truncate with

Digitized by Google

a very small emargination at the middle; upper surface slightly uneven. Eyes situated well up on the head, separated by a space not greater than diameter of each, rounded, moderately convex, finely granulated. Antennal cavities deep, small, near the tip of the beak, visible only from the side or from beneath. Antennæ half as long as the body; first joint stoutly clavate, second joint shorter, 3–8 each equal in length to the first, but more slender; ninth a little longer, gradually thicker externally, tenth transverse, eleventh oval-pointed, the three forming an elongate but not compressed club. Mentum with the lobes broadly rounded at tip. Prothorax narrowed from near the base forwards; ante-basal ridge strongly curved each side, with the concavity directed backwards, so as to form an angle at the middle, nearly touching the base, which is truncate; near the sides this ridge is flexed obliquely forwards, then on the sides it is bent forwards, and runs somewhat obliquely as far as the middle; the prothorax is deeply channeled behind the middle, and this channel is crossed at its anterior end by a short transverse impression. Elytra wider than the base of the prothorax, base straight for two-thirds of its width, then obliquely backwards leaving a scutellar excavation. Scutellum small, elevated, with a deep fovea behind. Disc of the elytra with a large elevation near the base of the third interspace, which is also uneven behind; the fifth and seventh are slightly uneven behind the middle. The first joint of the tarsi is longer, second triangular, emarginate, third a little narrower, bilobed; claws simple, divergent.

1. **G. gibbosus**, n. sp.

Subovate, convex, black, without lustre, beak, and sides of head below the eyes, densely clothed with fine white pubescence. Prothorax deeply channeled from before the middle to the base, and with a short deep transverse line at the middle; the edges of the cruciform impression thus produced are clothed with white pubescence; broadly concave near the sides adjacent to the transverse ridge. Scutellum white-pubescent. Elytra with fine punctured striæ and very densely finely punctured interspaces; a large saddle-shaped spot of white pubescence extends from the middle forwards becoming narrowed to the space between the third interspaces near the base, which it attains; there are also some smaller white and black pubescent spaces behind the middle. Beneath pruinose with fine whitish pubescence. Length 5 mm.; .20 inch.

One specimen, Colorado.

EURYMYCTER n. g.

The well-known species upon which this genus is established, represents in our fauna the European *Platyrhinus*, but differs by the beak being narrower than the head and strongly dilated at the tip; it is uneven above, with three wide grooves and two ridges, extending as far as between the antennæ, where they end, leaving the dilated part of the beak flat; the sides are extended over the antennal cavities, which are small and visible only from the sides and beneath. The mandibles are flat, acute, and

Digitized by Google

toothed on the inner side; eyes rounded, finely granulated. The antennæ are half as long as the body; first and second joints a little stouter, and nearly equal; 3–8 longer, shining; ninth of the same length, gradually thicker externally and sensitive; tenth about one-third shorter, oval, longer than wide, sensitive; eleventh elongate-ovate, pointed, as long as the ninth and sensitive; these joints are not compressed, and form an elongate loose club. Mentum with the lobes narrowly rounded, and subacute. Prothorax very uneven with large approximate foveæ; broadly transversely impressed before the middle; antebasal ridge nearly straight, about one-fifth from the base, which is strongly biemarginate for the reception of the bases of the elytra; at the sides, the ridge is bent at an obtuse angle, and descends obliquely, forming an obtuse lateral protuberance about the middle; in front of this the prothorax is gradually obliquely narrowed. The elytra are wider than the prothorax, uneven with short transverse rugosities and elevations; striæ composed of large distant punctures; base separately rounded and finely margined, not excavated near the scutellum, but obtusely elevated from the first to the fifth stria. The alternate interspaces are wider and more convex. The first joint of the tarsi is long, the second triangular and emarginate; third not narrower than second, bilobed; claws toothed at the middle. First and fifth ventral segments longer than the others.

1. **E. fasciatus**; *Macrocephalus fasc.* Oliv., Ins. iv, 80, 9; pl. i, f, 9; *Anthribus fasc.* Kirby, Fauna Bor. Am. iv, 206.

Northern States, Canada, Vancouver's Island. A large species conspicuous by the beak and a broad transverse band behind the middle of the elytra being clothed with snow-white hair. Length 6.5–9.5 mm.; .25–.37 inch.

TROPIDERES Schönh.

1. **T. bimaculatus** Lec., Proc. Ac. Nat. Sc. Phila. vii, 218; *Macrocephalus bim.* Oliv., iv, 80, 14; pl. 2, f. 19; *Anthribus quadrinotatus* Say, Journ. Ac. Nat. Sc. Phila. v, 249; ed. Lec., ii, 314.

New York, Wisconsin. A small, rather slender species, easily known by the white humeral spot and transverse subsutural spot behind the middle; the beak is broad, not longer than the head; the prothorax is feebly and obtusely tuberculate at the sides. The eyes are more widely separated, and more oblique than in the two preceding genera. The antebasal ridge is obtusely angulate at the middle with the angle directed forwards, and obtusely flexed on the sides. Length 4.7 mm.; .18 inch.

Gemminger and Harold have incorrectly referred *A. cornutus* Say to this genus; it will be found below under *Anthribus*.

2. **T. rectus**, n. sp.

Oval-cylindrical, dark brown, with spots of yellow pubescence, and upon the elytra also a few white dots. Head and prothorax opaque, very densely and rather finely punctured; antebasal ridge nearly straight and parallel with the base, suddenly flexed at the sides, and extending nearly to the

Digitized by Google

middle; the angle near the base at the flexure appears almost rectangular; sides obliquely and broadly rounded. Elytra with striæ of large punctures, interspaces even, alternately variegated with distant, small white dots; a spot of yellow and white hair covers the base of the 4–7 interspaces. Beneath thinly clothed with fine gray hair; legs mottled with gray hair; antennæ testaceous with dusky club, slender, extending to the base of the prothorax. Length 4 mm.; .15 inch.

Enterprise, Florida, two specimens; Mr. E. A. Schwarz. Quite different in appearance from the preceding, though presenting no special structural peculiarities.

ALLANDRUS Lec.

I have established this genus upon a small Canadian species remarkable by the sexual differences The form is as slender as in *Tropideres*; the beak is longer than the head, narrower at the base, slightly dilated at the tip; in the male it is furnished with a very high crest, gradually fading out in front; in the ♀ only an obsolete carina is seen. The antennæ in the ♀ extend to the base of the elytra, and are just as in *Tropideres*, except that the second joint is thinner; joints 9–11 form an oval, compressed club. In the ♂ the antennæ are as long as the body; joints 3–8 elongated, and a little thickened at tip; 9–11 flattened, forming a loose club. The prothorax as in *Tropideres*, but not tuberculate at the sides; transverse ridge remote from the base, feebly curved, and subsinuate; flexed obliquely forward at the sides. Eyes rounded, lateral, prominent, finely granulated. Tarsi more slender than usual; third joint not as wide as the second; claws appendiculate rather than toothed. Mentum with the lobes wide, narrowly rounded at tip; ligula large and coraceous, filling up the emargination of the mentum more than in the preceding genera, (somewhat as in certain *Lebiini*).

1. **A. bifasciatus**, n. sp.

Blackish brown, with a brassy tinge; head and prothorax densely punctured, thinly clothed with cinereous hair; the latter longer than wide, narrowed at tip and base; elytra with punctured striæ, and two ill-defined, broad bands of cinereous hair; the anterior one extending along the suture to the base; scutellum white. Length 4.3 mm.; .17 inch.

Canada, one pair, Mr. Billings; Illinois, one ♀, Mr. B. D. Walsh. This is *Tropideres oblongus* ‡ Dej. Cat.

Group III. Hormisci

The genera upon which I have founded this group, seem sufficiently distinct from the other *Corrhecerides* of Lacordaire to be separated from them. I would define it by the following characters:

Beak not dilated at the sides over the antennal cavities. Eyes emarginate, not finely granulated. Prothoracic ridge antebasal, curved or obtusely angulate backwards at the middle, flexed obliquely forward at the sides. Tarsi with the first joint long; second triangular, scarcely emarginate;

Digitized by Google

third bilobed, not narrower, but shorter than the second; claws acutely toothed at the middle. Mentum transverse, less deeply emarginate than usual, with the emargination nearly filled by the broad basal piece of the ligula; transverse suture between the gula and mentum distinct.

Antennal club 3-jointed..........................	2.
" " solid, sensitive only at tip............	HORMISCUS.
2. Eyes feebly emarginate; claws indistinctly toothed..	TOXOTROPIS.
Eyes strongly emarginate; claws cleft almost to the base..	GONOPS.

HORMISCUS Wollaston.

In this genus the form is cylindrical and less slender than in *Tropideres*. The beak is broad and flat, not longer than the head, with the antennal cavities lateral, not covered by the sides. Eyes rather large, less finely granulated, oblique, feebly emarginate; antennæ alike in both sexes, hardly extending to the base of the prothorax, club oval, apparently solid. Prothorax scarcely longer than wide, gradually narrowed in front; more rapidly narrowed behind the transverse carina, which is slightly oblique, parallel with the base, and ends each side in a lateral cusp.

1. **H. saltator**, n. sp.

Brownish black, mottled with spots and bands of cinereous pubescence; prothorax densely and finely punctured; elytra with rows of large and deep punctures, about twice as long as the prothorax. Length 1.2–1.6 mm.; .05 –.07 inch.

Middle and Western States, not rare; I have adopted the specific name with which it is labeled in the collection of the late Dr. Zimmermann. There are few prominent characters in this singular little insect, except such as are of generic value. It agrees with the Galipagoan *H. variegatus* in having the transverse ridge of the prothorax broadly angulated at the middle, but the latter differs, according to description, in color, and in having the elytra indistinctly punctato-striate. The specimens vary greatly in appearance, according as the pubescence is more or less abraded. In the best preserved individual, the prothorax is mottled, and the elytra also, but the mottlings of the latter are arranged so that a subscutellar space on each elytron, and a broad, post-medial band not reaching the margin, are left free from cinereous spots. The posterior transverse carina of the prothorax is slightly oblique, forming a very obtuse angle backwards on the median line, and projects at the side as a small, sharp cusp.

TOXOTROPIS n. g.

This genus is closely related to *Hormiscus*, and in fact only differs from it by the antennal club which is elongate-oval, compressed, and composed of three distinct joints equal in length. The eyes are rather finely granulated, and only feebly emarginate; the antennal cavities are small and rounded. The antebasal ridge is regularly curved in an arc of a circle, for

Digitized by Google

the greater part of its length, but directed transversely towards the sides, and not flexed forwards; claws feebly toothed at the middle.

1. **T. pusillus**, n. sp.

Of the same size, form and color as *Hormiscus saltator*, brown, varied with patches of fine white pubescence; eyes larger and more prominent; prothorax more finely punctured. Elytra with striæ of rather large punctures; interspaces even. Length 1.2 mm.; .05 inch.

Tampa, Florida, one specimen, Mr. E. A. Schwarz.

2. **T. approximatus**, n. sp.

Of the same form, color and sculpture as *T. pusillus*, but the antebasal ridge is less curved, and therefore is more parallel with, and nearer to the base than in that species. The hind angles near the base are therefore less prominent, and the body is somewhat stouter. Length 1.5 mm.; .06 inch.

One specimen, San Diego, Cal.; Mr. G. R. Crotch.

GONOPS n. g.

This genus is also related to the two preceding, but differs from *Hormiscus* by the antennal club compressed, and composed of three joints equal in length; the antennal cavities are small, and the eyes are deeply emarginate and rather finely granulated. It differs from both by the claws being cleft almost to the base, with the inner portions converging as in *Anthonomus*. It also differs from all the other genera in our fauna by the middle and hind tibiæ being armed with a small mucro or spine at the inner side of the tip. The form is a little stouter than in *Hormiscus*; the antebasal ridge of the prothorax is curved in the arc of a circle; towards the sides it is nearly transverse, and is not flexed forwards.

1. **G. fissunguis**, n. sp.

Oblong, rather robust, brown, mottled with small spots of yellowish gray pubescence. Head and prothorax opaque, very densely and finely punctured; the latter a little wider than long, narrowed from the end of the ridge forwards, but scarcely rounded on the sides; rapidly and concavely narrowed behind the ridge, the end of which forms an acute lateral angle. Elytra not wider than the widest part of the protharax, convex; striæ composed of moderate sized punctures, interspaces very finely punctulate. Length 2.5 mm.; .10 inch.

Three specimens from Big Trees, California; sent by Mr. James Behrens to Dr. Horn.

Tribe II. BASITROPINI.

The only characters of a general kind which can be given to distinguish this from the other tribes, are that the antennæ are inserted under the sides of the beak, and that the prothoracic ridge is quite basal, causing the surface behind it to become perpendicular; it consequently attains the hind angles, and is there flexed forwards, not obliquely and at an obtuse angle, but rectangularly. As a farther consequence of this arrangement, the basal margin of the elytra is acute.

Digitized by Google

Our species represent but three groups:

Beak with parallel or nearly parallel sides..............	2.
" narrower in front, trapezoidal....................	Brachytarsi.
2. Tarsi with third joint wider, deeply bilobed, visible from above..	Anthribi.
Tarsi with the third joint bilobed, not visible from above	Cratopares.

Group I. **Anthribi.**

These species are sufficiently distinguished from *Cratoparis* by the third joint of the tarsi being not narrower than the second, and quite visible from above; the second joint is broad, triangular and rather flat, emarginate at tip. The sides of the beak partly cover the antennal cavities, which are large and deep, and but slightly visible from above. The antennæ are sometimes very long in the ♂, and the first joint is stouter and shorter than usual. The tarsal claws vary according to genus. Except in *Anthribus* the antennal cavities are somewhat distant from the eyes.

Hind angles of the prothorax not directed outwards.......................................	2.
Eyes emarginate, hind angles of prothorax directed outward; front coxæ contiguous......	EUSPHYRUS.
2. Front coxæ contiguous or nearly so............	3.
" " well separated by the prosternum.	4.
3. Claws almost cleft, body elongate-cylindrical, eyes emarginate..........................	PHŒNICOBIUS.
Claws feebly appendiculate, body stout subcylindrical, eyes oval......................	PIEZOCORYNUS.
4. Eyes rounded................................	ANTHRIBUS.
Eyes broadly emarginate......................	TOXONOTUS.

EUSPHYRUS n. g.

The beak is shorter than the head, broader than long, slightly narrowed at base, obliquely narrowed in front of the widest part, not emarginate at tip, but bordered as usual with a coriaceous clypeus; eyes moderate, ovate, broadly emarginate in front, not coarsely granulate; antennæ not longer than head and thorax; first and second joints thicker not elongated, 3–6 slender, gradually a little shorter, seven and eight slightly thicker, 9–11 equal in length, forming a loose compressed club. Prothorax wider at base than its length, gradually narrowed from the base, feebly rounded at the sides, not projected over the head in front, but truncate; hind angles acute, prominent laterally; transverse ridge absolutely basal, scarcely extending along the sides. Elytra cylindrical, deeply punctato-striate, not wider than the prothorax, and about twice as long. Front coxæ prominent, contiguous; tarsi as long as the tibiæ; first joint as long as the others united, third joint not narrower than the second, very short; claws with a small acute tooth near the base. Mentum more narrowed behind than usual, buccal fissures wider.

Digitized by Google

1. **Eu. Walshii** n. sp.

Elongate-oval, subcylindrical, brownish-black, opaque, clothed with fine cinereous pubescence, and mottled with patches of yellowish-white hair; head and prothorax densely and finely punctured, the latter feebly bisinuate at base, with the hind angles acute, divergent; elytra with deep strongly punctured striæ, disc broadly impressed transversely about one fourth the length from the base; antennæ at base, tibiæ and tarsi dark testaceous. Length 3.2 mm.; .13 inch.

One specimen, Illinois; B. D. Walsh. This species has the general appearance of *Brachytarsus*, and without examination of the characters of the genus and group might readily escape recognition.

PHŒNICOBIUS n. g.

Body elongate-cylindrical. Beak about as long as wide; sides acutely elevated in the ♂, but less so in ♀, limiting the antennal cavities which are large and deep, extending nearly to the tip, but not limited behind, and not reaching the eyes; the beak is emarginate in front, and finely carinate, the carina terminating behind in an angulated impressed line. Eyes coarsely granulated, rounded, somewhat transverse, broadly emarginate in front. Antennæ (♂) much longer than the body; first joint thick, one-half longer than wide; second one-half the length, and much thinner; 3–5 very long, equal, extending to the second ventral suture; 6–9 gradually a little shorter, densely fringed beneath with short, fine, curled hairs; 10–11 together longer than ninth, not thicker, similarly fringed; 11th pointed and slightly curved. Mentum with the lobes rather acute at tip, and the bottom of the emargination straight. Prothorax longer than wide, narrowed in front of the middle and slightly rounded on the sides; basal ridge flexed rectangularly at the sides, and extending a little in front of the middle; inferior basal margin, (on the perpendicularly declivous face which is adapted to the base of the elytra), finely crenulate. Elytra not wider than the base of the prothorax, margined at base; scutellum small, rounded, not depressed; striæ composed of large punctures, interspaces nearly smooth.

Front coxæ very narrowly separated by the prosternum. Tarsi with the first joint not longer than the second and third; second broadly triangular, with the apical angles prolonged; third joint still wider, excavated above for the articulation of the next joint, but scarcely emarginate beneath, forming a broad cushion as in certain *Calandridæ*, not less dilated in ♀ than ♂; claws with a long, basal tooth, causing them to appear almost cleft as in *Anthonomus*. The ventral segments gradually diminish in length; the fifth is broadly emarginate; the pygidium is channeled more deeply than usual, and the groove extends nearly to the tip.

The antennæ of the ♀ are three-fourths as long as the body; the joints are proportioned relatively as in the ♂, but the last three (9–11) are broader, forming a loose, elongate club, which is slightly fringed beneath. The other joints are not fringed.

Digitized by Google

1. P. Chamæropis, n. sp.

Elongate-cylindrical, brown, mottled with fine pubescence of gray, yellow, fulvous and black colors; head and prothorax coarsely punctured; elytra with the first and alternate interspaces slightly more convex, tessellated with black and yellow; the intervening spaces with cinereous hair. Under surface mottled; metasternum densely clothed with yellowish-white pubescence. Legs and antennæ also mottled with gray and dark brown pubescence; the outer half of the ninth and the whole of the tenth and eleventh joints of the antennæ are nearly black. Length (♂) 7.8–11 mm.; .29–.44 inch; (♀) 4.5–9.8 mm.; .18–.37 inch.

Florida, abundant on *Chamærops palmetto*; Messrs. Hubbard and Schwarz.

The antennæ of the smallest ♂ are scarcely longer than the body; those of the largest are nearly double the length. This is *Anthribus cylindricus* ‡ Dej. Cat.

PIEZOCORYNUS Sch.

Body stout, cylindrical. Beak broad, flat, not as long as wide, not emarginate at tip; antennal cavities large and deep, not extending to the eyes, partially covered by the sides of the beak. Eyes subtriangular, coarsely granulated. Antennæ (♂)* one-half longer than the body; first joint stout, rounded; second nearly twice as long, conical; 3–8 more than twice as long as the second, slightly thickened towards the tip; 5–8 feebly carinate on the outer face; eighth more flattened towards the tip than the others, 9–11 forming a compressed, elongate club, pubescent and sensitive, in which the tenth and eleventh joints together are shorter than the ninth; the last named is obliquely emarginate at tip, and twice as long as wide; the tenth is transverse and similarly emarginate. Mentum with the lobes subacute at tip, the emargination rounded, and the buccal fissures rather wide. Prothorax wider than long, truncate at base, with the ridge flexed rectangularly at the hind angles, and extending along the sides nearly to the tip; sides gradually converging and slightly rounded. Elytra not wider than the prothorax, with punctured striæ; third and fifth interspaces wider and slightly more convex. Front coxæ nearly contiguous; tarsi with the first joint a little longer than the second, which is broad, triangular and emarginate; third joint wider than the second, deeply bilobed; claws broadly but not strongly appendiculate.

The antennæ of the ♀ are about one-half as long as the body; the second joint is longer and more slender; the subsequent joints 3–8 are about one-half longer than the second, and the club is broader.

Antennæ not very slender; prothorax with two shallow depressions and three elevations occupying the middle third..	1. **dispar.**
Antennæ very slender; prothorax without impressions or elevations; pubescence mottled yellow brown and black	2. **mixtus.**

*This description is made from *P. dispar*; it is still doubtful if the sexual differences exist in the other species.

Digitized by Google

Antennæ very slender; prothorax without impressions or elevations; pubescence nearly black.................. **3. mœstus.**

1. **P. dispar** Gyll., Sch. Curc. i, 140.

This species, first described from Brazil, occurs in Missouri and Texas. It differs from the following in the proportions of the antennal joints, but not sufficiently to place the species in separate genera; the markings of the elytra are similar, but in the present species, in well preserved specimens, there is a greater condensation of ochreous pubescence along the first and second interspaces, which thus cease to be tessellated. Length 6.1–7.3 mm.; .24–29 inch.

2. **P. mixtus** n. sp.

Middle and Southern States, rare. Oblong-cylindrical, opaque, brown, mottled with testaceous; head and prothorax very densely punctured, the latter narrowed in front, not rounded on the sides; elytra with an obtuse elevation each side near the base, striæ composed of deep approximate punctures, interspaces tessellated; antennæ very slender, joints of the club equal in length. Length 4.7–6 mm.; .17–.24 inch.

Of the same form and color as *P. dispar,* but smaller, with the sides of the prothorax nearly straight, and the antennæ more slender, and quite different in the terminal joints. The second joint is more strongly clavate, the 3–8 very slender, gradually diminishing in length as in *P. dispar* ♀, but more slender, the eighth being very feebly triangular, ninth, tenth and eleventh forming a loose club, the two former not emarginate, the latter not narrower; the ninth is longer than the eighth, and the tenth and eleventh a little shorter.

Three specimens are before me, in which I can perceive no sexual differences; the antennæ are about two-thirds the length of the body. This is *Tropideres caliginosus* † Dej. Cat.

3. **P. mœstus**; *Anthribus mæstus* Lec., Ann. Lyc. Nat. Hist. N. York, i, 172; pl. xi, f. 13.

Georgia and Florida. This species exactly resembles the preceding, except that it is a little more robust, and the pubescence is finer and of a grayish-black color, tessellated with black on the elytra; the only white spots are two small dots on the prothorax, one at the middle of the apical margin, the other in front of the scutellum, which is also white. The legs are annulated with dark cinereous. Length 4 mm.; .16 inch.

The figure given by my father, like all others on the plate, is quite characteristic.

ANTHRIBUS Fabr. (nec Geoffroy); emend. Lac.

Lacordaire has restricted this generic name to those members of the present tribe in which the front coxæ are rather widely separated by the prosternum. Additional characters are: the beak flat with parallel sides, wider than long and feebly carinate in the first species; eyes rounded, convex, coarsely granulated; antennal cavities large, extending to the eyes. Antennæ half as long as the body, second joint somewhat longer

Digitized by Google

than the third, and equal to the fourth; 4–8 slightly diminishing in length and increasing in thickness; 9–11 forming a compressed oval club. Prothorax with the ridge extending along the sides to the middle. Elytra cylindrical, not wider than the prothorax, with striæ composed of large punctures. Tarsi with the first joint a little longer than the second, which is triangular and emarginate; third as wide as the second, deeply bilobed; claws acutely toothed at the middle. Mentum with the lobes subacute at tip, gula transversely impressed just behind the buccal fissures.

Pubescence tufted; elytra with a large transverse white spot
in front of the middle .... 1. **cornutus.**
Pubescence short, uniform, dense, yellowish-gray.......... 2. **lividus.**

1. **A. cornutus** Say, Curc. 4; ed. Lec., i. 262; *A. coronatus* Gyll., Sch. Curc. i, 141.

Atlantic States, especially Georgia and Louisiana. Easily recognized by the tufts of hair on the prothorax and elytra, and by the conspicuous common transverse white spot in front of the middle, which extends to the sixth stria. Length 4.6–5.8 mm.; .18–.23 inch.

2. **A. lividus** n. sp.

Elongate-cylindrical, brown, densely clothed with short depressed mud-colored hairs, club of antennæ dark. Beak entirely flat, not at all carinate. Prothorax longer than wide, slightly rounded on the sides, narrowed from the middle to the apex, which is broadly rounded; side margin extending to the middle. Elytra with striæ composed of distant small punctures, entirely even and equal in width. Pygidial groove very short, not extending beyond the tips of the elytra. Length 4.4 mm.; .17 inch.

One specimen, Lake Harney, Florida; Messrs. Hubbard and Schwarz. The front coxæ are less separated than in *A. cornutus*, but are far from being approximate, as in the other genera of the tribe. I have adopted the name under which it appears in the catalogue of Dejean.

TOXONOTUS Lac.

1. **T. fascicularis** Lac., Gen. Col. vii, 576; *Anthribus fasc.* Sch., Curc. i, 132.

A fine ♂ of this well-known Cuban species was found by Mr. E. A. Schwarz at Enterprise, Florida, in May. The reniform eyes and legs thickly clothed with erect flying hairs, as in many *Cerambycidæ*, entitle it fully to generic recognition; and the prolongation of the first joint of the tarsi into a long spine in the ♂ is a singular character, not occurring in any other member of the family. Length 9.2 mm.; .37 inch.

Group II. Cratopares.

The insects of this group, represented by only two species in our fauna, differ from the *Anthribi*, chiefly by the second joint of the tarsi less dilated, longer, and though deeply emarginate at tip, concealing the third joint so that the articulation is not visible from above; but merely the lobes, which do

Digitized by Google

not extend beyond the prolonged angles of the second joint. The beak is flat and parallel on the sides; the antennal cavities extend to the eyes, which are oval and coarsely granulated, somewhat truncate in front. The side margin of the prothorax extends to about the middle; the base is slightly bisinuate, and the lower basal margin is very well defined, so that when the prothorax is deflexed, it might be supposed that the transverse ridge was not absolutely basal. The same is the case, though to a less extent, in the genera of the preceding group. The front coxæ are contiguous, and the mentum is but feebly emarginate in our species; the buccal fissures are rather wide.

CRATOPARIS Sch.

Our two species differ by the color of the pubescence:

Brown, with the sides of the prothorax, and large elytral spot concave backwards, yellowish-gray, rest of the surface mottled .... 1. **lunatus.**

Black, varied with white; elytral spot irregular, extending to the base, enclosing a quadrate black scutellar space, apex of elytra white .... 2. **lugubris.**

1. C. **lunatus** Fahraeus, Sch., Curc. v. 221; Labram and Imhoff, Gen. Curc. i, 56; *Anthribus lun.* Fabr., Syst. El. ii, 409; *Macrocephalus albifrons* Oliv., iv, 80, 12, pl. 2, f. 16; *Anthribus albifrons Boh.*, Bull. Mosc. vi. 18; *Euparius lunatus* Gyll., Sch. Curc. i, 140. *Euparius paganus* Gyll., Sch. Curc. i, 142; *Cratoparis pag.*, ibid. v, 225, small specimens.

Atlantic States, abundant. The larva is described by Chapuis and Candéze, Cat. Larv. Col. p. 200.

2. C. **lugubris** Fahraeus, Sch., Curc. v, 224; *Macrocephalus lug.* Oliver, iv, 80, 13, pl. 2, f. 17; *Euparius lug.* Gyll., Sch., Curc, i, 141; *Anthribus notatus* Say, Journ. Ac. Nat. Sc. Phil. v, 248; ed. Lec., ii, 312.

Atlantic States, abundant southwardly.

Group III. **Brachytarsi.**

In this group the beak is gradually narrowed from the eyes forwards, so as to become trapezoidal in form; the antennal cavities extend to the eyes, which are coarsely granulated and emarginate in front. The first and second joints of the antennæ are stout, the second a little longer, 3–8 shorter, gradually a little wider; 9–11 much wider, forming an oval compressed sensitive club. Prothorax rounded in front, overhanging the head, basal ridges flexed rectangularly at the angles, but extending only a very short distance along the sides; inferior basal margin acute. Elytra with even and equal interspaces. Tarsi with the first joint scarcely longer than the second, which is triangular and emarginate; third deeply bilobed, not narrower than the second, claws toothed near the tip, so as to appear cleft. Mentum deeply emarginate with lobes, rounded at tip; gula transversely impressed.

Our species represent two genera, one of which has not been previously recognized.

Digitized by Google

Basal ridge flexed abruptly forwards at the hind angles, and continued along the sides of the prothorax for a short distance............... **BRACHYTARSUS.**
Basal ridge gently rounded and becoming obsolète at the hind angles........................... **ANTHRIBULUS.**

BRACHYTARSUS Sch.

This genus contains the type of Geoffroy's genus *Anthribus*; but in consequence of his only semi-recognition of the binominal Linnæan nomenclature, of a definition properly accompanied by a specific name, indicating the object described, was delayed until 1799. The generic name thus proposed by him (1764), was appropriated by Olivier (1789), and by Latreille and Fabricius subsequently, and applied to an assemblage of species now divided into several genera. Schönherr afterwards divided this assemblage of species, and gave the name *Brachytarsus* to the genus here treated of. I cannot, therefore, advise the restoration of the name *Anthribus*, with the authority Geoffroy, to this genus, even though it be sanctioned by the authority of the Munich Catalogue, and the Check List of Mr. Crotch.

Legs testaceous not annulated........................ 2.
Legs brown, annulated with darker; elytra tessellated on the alternate interspaces.......................... **1. alternatus.**
2. More elongate, densely and coarsely pubescent with yellowish-gray hair, with indistinct stripes of gray.. **2. griseus.**
Pubescence coarse and dense, yellowish-gray, slightly mottled with paler dots on the elytra.............. **3. limbatus.**
Pubescence finer, scarcely mottled, body more elongate than in *B. limbatus*............................ **4. plumbeus.**
Pubescence coarse and dense, brownish-yellow, not mottled; smaller and more elongate than *B. limbatus*.. **5. vestitus.**
Shorter and stouter, pubescence finer, gray, not mottled; thighs usually dusky.......................... . **6. tomentosus.**
Longer, pubescence grayish-yellow, mottled with dark brown, elytra each with a basal spot, and another behind the middle................................. **7. variegatus.**

1. B. **alternatus.** *Anthribus alt.* Say, Journ. Ac. Nat. Sc. Phila. v, 250; ed Lec., ii, 314.

New York, Missouri and Texas; of the same form, size and color as *Araocerus coffea*, but quite different by the form and position of the antennæ.

2. B. **griseus**, n. sp.

Elongate, subcylindrical, piceous, densely clothed with rather coarse gray hair, verging towards ochreous in places, but without definite pattern. Head as in *B. limbatus*. Prothorax longer than its width at base, rounded, but scarcely narrowed on the sides as far as the middle, then more obliquely rounded and narrowed to the tip, which is rounded as usual; base

Digitized by Google

broadly rounded, sinuate near the hind angles, which are acute; disc strongly punctured, but the punctures are concealed by the dense pubescence. Elytra not wider than the base of the prothorax, and about twice as long as it; striæ narrow, rather finely punctured. Legs and antennæ yellowish-brown, club darker. Length 3.5 mm.; .14 inch.

Colorado, six specimens; Prof. F. H. Snow. The body is elongate as in *B. variegatus*; the pubescence is nearly uniform, but there are, sometimes, three paler gray vittæ on the prothorax, and a broad one occupying the 5th and 6th interspaces of the elytra. The side margin produced by the flexure of the basal ridge extends nearly one-half of the length of the prothorax.

3. **B. limbatus** Say, ibid. v, 250 (*Anthribus*); ed. Lec., ii, 314.

Atlantic States, varies in size from 2.2–3.1 mm.; .09–.12 inch.

4. **B. plumbeus**, n. sp.

Oblong, cylindrical, black, densely clothed with cinerous pubescence, not mottled; striæ of elytra fine, punctured; antennæ and legs testaceous, club and thighs darker. Length 3.2 mm., .13 inch.

Middle States. Of the same form as *B. limbatus*, but a little narrower; the pubescence is finer, of a uniform gray color. The posterior ridge extends only one-third the length of the prothorax at the sides, while in *B. limbatus* it goes fully as far as the middle.

5. **B. vestitus**, n. sp.

Oblong-cylindrical, black, densely clothed with coarser brownish-yellow pubescence, scarcely mottled striæ of elytra punctured, interspaces flat; antennæ and legs testaceous. Length 2 mm.; .08 inch.

Louisiana; Mr. Ulke. Smaller and narrower than *B. limbatus*, densely covered in the same manner with coarse, brownish-yellow pubescence; the hind angles of the prothorax are acute; but the transverse ridge scarcely extends along the sides in front of the base.

6. **B. tomentosus** Say, Journ. Ac. Nat. Sc. Phila. v. 251 (*Anthribus*); ed. Lec., ii, 315. *Brachytarsus brevis* Fahræus, Sch. Curc. v, 168.

Middle and Western States; on *Ambrosia* (C. V. Riley). The ridge extends from the hind angles about one-third the length of the prothorax.

7. **B. variegatus** Say, Journ. Ac. Nat. Sc. Phila. v, 251 (*Anthribus*); ed. Lec., ii, 315; *Brachytarsus sticticus* Gyll., Sch. Curc. i, 172.

Atlantic States; Say notes its occurrence in the smut of wheat. A species of rather elongate form, and easily known by the basal and postmedial fuscous spots near the suture; varieties however occur in which these spots are obsolete, and the specimens are then to be distinguished from *A. limbatus* by the narrower form, and more elongate prothorax. Such specimens probably represent *B. obsoletus* Fahraeus, Sch. Curc. v, 167. The ridge extends from the base along the sides for about one-half the length.

ANTHRIBULUS n. g.

The small species upon which I have founded this genus is of more elongate form than *Brachytarsus*, but agrees with it in the trapezoidal

Digitized by Google

form of beak, and the first joint of the tarsi not longer than the second. It differs, however, by the basal ridge of the prothorax being not rectangularly but only obtusely flexed at the outer ends, and not continuing along the sides. The claws are cleft at the tips for about one-fourth their length.

1. **A. rotundatus**, n. sp.

Elongate, dark brown, densely clothed with pale, cinereous and brown pubescence; prothorax broadly rounded on the sides, hind angles rounded; elytra oval, convex, striæ deep, punctured. Length 1.4–2.4 mm.; .05–.09 inch.

Massachusetts to Louisiana. This species differs in form from the *Brachytarsi* by having the sides of the prothorax broadly rounded, and the elytra slightly narrowed and rounded near the base. The body is rather elongate, proportioned nearly as in *B. variegatus*, dark brown, densely clothed with brown and silvery gray pubescence; the head is flat, and the rostrum slightly narrowed at the insertion of the antennæ; the latter are testaceous, with the club fuscous; prothorax longer than wide, gradually narrowed in front and rounded on the sides, tip rounded; base broadly rounded, transverse ridge not continued along the sides; hind angles obtuse, slightly rounded. Elytra oval, convex, a little wider than the base of the prothorax; humeral angles rounded, not prominent; striæ rather deep, punctured; legs testaceous. The antennæ are rather stouter than in *Brachytarsus*, and scarcely attain the base of the prothorax.

Tribe III. ARÆOCERINI.

But two genera of this tribe have occurred in our fauna; they are of small size, and are easily known by the antennæ being inserted in small foveæ upon the upper surface of the beak. The transverse carina of the prothorax as in the preceding tribe is basal, suddenly flexed, forming a right angle, and extended a short distance along the sides; the antennæ are slender, and the last three joints form a loose club. The elytra are regularly striate as in all the preceding tribes and groups of the family.

Antennæ with second joint shorter than the first............ **Aræocerus.**
" " " as long as the first, elytra striate. **Choragus.**

ARÆOCERUS Sch.

1. **A. fasciculatus** Wollaston, Ann. Nat. Hist. v, (1870), 18; *Curculio fasc.* DeGeer, Mem. Ins. v, (1775), 276, pl. xvi. f. 2; *Bruchus cacao* Fabr., Syst. Ent. 64; Ent. Syst. 1, 2d, 370; Syst. El. ii, 397; *Macrocephalus cacao* Oliv., Ent. iv, No. 80, 15, pl. 2, f. 21; *Anthribus coffeæ* Fabr., Syst. El. ii, 411; *Aræocerus coffeæ* Gyll., Sch. Curc. i, 175; Labr. and Imhoff, Curc. i, 55; *Anthribus capillicornis* Say, Journ. Ac. Nat. Sc. Phila. v, 249; ed. Lec., ii, 313.

Atlantic and Pacific States in articles of commerce. This cosmopolitan species has many other synonyms, which may be found in Harold and Gemminger, Cat. Col. p. 2749. From these must be excluded *Anthribus mæstus* Lec., Ann. Lyc. New York, i, 172, which, as mentioned above, belongs to *Piazocorynus*.

Digitized by Google

CHORAGUS Kirby.

1. **C. Zimmermanni**, n. sp.

Oval-subcylindrical, brown, without lustre, slightly pubescent, prothorax densely punctured, elytra deeply striato-punctate, interspaces densely and finely punctulate, antennæ and legs yellow. Length 1.3 mm.; .06 inch.

North Carolina; Dr. C. Zimmermann. According to description this species differs from the European *C. Sheppardi* by the prothorax not being very finely punctured, and from *C. piceus* by the elytra not being shining.

2. **C. Sayi**, n. sp.

Elongate-oval, subcylindrical, blackish, prothorax densely punctured, slightly pubescent, elytra deeply striato-punctate, shining, interspaces less densely and more distinctly punctulate; antennæ dark testaceous, feet piceous. Length 2.3 mm.; .09 inch.

Washington, D. C.; Mr. Ulke. Larger and narrower than the preceding, with darker legs, and shining elytra.

Tribe IV. XENORCHESTINI.

The species of this tribe have lost all appearance of the family, and indeed of Rhynchophora. The only one known to me in our fauna might be readily mistaken for a small *Cryptocephalus;* while the Maderan species figured by Wollaston* seems to resemble in miniature *Gibbium*.

The body is oval or ovate, very convex, and quite glabrous. The beak is so short as to be not distinct from the front; the antennæ are inserted upon the front, which is deflexed; the eyes are small, transverse oval. The first and second joints of the antennæ are longer and stouter; 3–7 shorter and thinner, nearly equal; eighth subtriangular, a little wider, 9–11 wider forming a loose club. Prothorax narrowed from the base forwards, ridge entirely basal, flexed at the hind angles, and continuing a short distance along the sides. Scutellum invisible. Elytra not striate. Tarsi with the first joint elongated; second triangular, emarginate; third bilobed; claws slender, not toothed.

Two genera would seem to be indicated; the first of which is unknown to me in nature.

Upper surface smooth.......................... XENORCHESTES.
Prothorax punctured; elytra with irregular double
rows of punctures......................... EUXENUS.

XENORCHESTES Woll.

1. **X. americanus** Motsch., Bull. Mosc. 1873, ii, 251.

Unknown to me; found on bushes near Mobile, Alabama. The following is the description given by Motschulsky:

Statura et color *X. saltitantis* sed duplo minor; gibbosus, acariformis,

* Insecta Maderensia, pl. viii, f. 8. The maxilla has a strikingly Adephagous form, the inner lobe being curved, acute, and sparsely spinose on the inner edge.

Digitized by Google

antice attenuatus, nitidus glaber, niger; elytris subæneascentibus, antennis pedibusque ferrugineo-testaceis ; capite obtuso, oculis planiusculis ; thorace antice capitis latitudine, subconico, postice latiore, basi simpliciter truncato ; elytris antice thoracis latitudine, postice ovato-dilatatis. Long. $\frac{2}{3}$ lin.; lat. elytr. $\frac{1}{4}$ lin.

EUXENUS n. g.

I can give no other characters for distinguishing this genus, except the punctured surface and less ovate form of body.

1. **E. punctatus** n. sp.

Oval. very convex, slightly narrower in front; brownish-black, glabrous shining; sides of elytra piceous, base of antennæ and legs testaceous. Head feebly punctulate. Prothorax a little wider at base than long, gradually narrowed from the base forwards; tip broadly rounded, base nearly rectilinear; disc deeply but not coarsely punctured. Elytra scarcely wider than the base of the prothorax, and punctured similarly, except that the punctures are arranged in irregular double rows, with narrow intervening smooth spaces. Beneath brownish, punctured; ventral segments short, equal. Length 1.2 mm.; .05 inch.

Detroit, Michigan; one specimen; Messrs. Hubbard and Schwarz. Dr. Horn has received another from Canada. The head is so much deflexed that I cannot examine the form of the mentum without risk of breaking the insect.

Family XI. APIONIDÆ.

Mentum narrow, linear, much longer than wide, inserted upon a short gular peduncle of equal width ; slightly channeled at tip, reaching nearly to the mandibles, and quite concealing the ligula and palpi, which are very small, maxillæ entirely filling the buccal fissures with a large corneous mass ; palpi not visible ; on dissection they appear very short, with not more than three joints ; there is but one broad lobe, densely fringed with hairs. Mandibles three-toothed, the middle tooth curved, acute, forming the apex ; near the tip on the anterior edge is a small tooth ; the third tooth is on the inner side and very large.

Antennæ inserted at the sides of the beak, in foveæ, eleven-jointed, straight, first joint longer than second ; these two are stouter than the succeeding ones ; 9–11 broader and longer, forming an oval pubescent club, which is pointed at the end.

Head prominent, not deflexed, not narrowed behind the eyes, which are rounded, convex, and not finely granulated ; beak long and slender, sometimes stouter towards the base ; without antennal grooves.

Prothorax truncate, in front, without postocular lobes, subsinuate behind, gradually narrowed from base to tip ; prosternum very short, coxal cavities rounded, confluent, closed behind ; prosternal sutures distinct.

Mesosternum small, narrow between the coxæ ; side pieces diagonally divided ; epimera triangular, pointed at the inner side, and not attaining the

Digitized by Google

coxal cavities. Metasternum a little longer than the first ventral segment, side pieces narrower.

Elytra ample, sometimes almost ventricose, deeply striate, entirely covering the pygidium ; without epipleuræ ; fold on the inner surface parallel with the side margin, diverging gradually from it towards the tip. Wings large.

Abdomen with the first and second ventral segments large, closely connate, with a fine straight suture ; third and fourth segments very short, sutures straight; fifth longer, flat, rounded at tip ; dorsal segments membranous, pygidium small; anterior coxæ conical, prominent, contiguous ; middle coxæ round, slightly separated; hind coxæ small, transverse, rather widely separated.

Legs rather long and stout; thighs somewhat clavate, tibiæ truncate at tip, without spurs, or spines ; tarsi dilated, first point scarcely longer, third bilobed ; claws divergent, appendiculate, toothed, or simple.

The species of this family are small, and have a peculiar and easily recognized appearance. Lacordaire has placed them, as a tribe near his *Attelabides*, with which, however, as will be seen by the foregoing description, they have but little resemblance, or affinity.

Lacordaire describes them as apterous ; in all the species I have examined the wings are quite well developed. I also find that in many of our species the claws are toothed or appendiculate, while in a few they are simple, and I have therefore attempted to group them in my collection upon those characters, the position of the antennæ, and the relative length of the first and second joints of those organs.

The species are numerous, and many are yet undescribed. It seems hardly worth while to affix names to them, until they have been collected, with reference to the plants which they infest. I will, therefore, on the present occasion give only the bibliography of the described species, in alphabetical order, with such notes on their habits, as I have been able to obtain.

APION Herbst.

1. **A. cavifrons** Lec., Pac. R. R. Expl. and Surveys, Ins. 53. Oregon.

2. **A. cinereum** Gerstaecker, Stettin Ent. Zeitung, 1854, 250. South Carolina.

3. **A. crassinasum** Lec,, Pac. R. R. Expl. and Surveys, Ins. 53, California.

4. **A. cribricolle** Lec., Pac. R. R. Expl. and Surveys, Ins. 53 ; *A. porosicolle*, Gemm., Col. Hefte, viii, 122. California. The change of name was suggested in the Munich Catalogue, but was afterwards withdrawn by Dr. Gemminger as unnecessary.

5. **A. cuprescens** Mann., Bull. Mosc., 1843, ii, 289. Alaska.

6. **A. lanuginosum** Walsh, Proc. Ent. Soc. Phila., 1867, 269. Illinois, from galls *Salix strobiloides* produced by a species of *Cecidomyia*.

7. **A. melanarium** Gerst., Stett. Ent. Zeit., 1854, 261.

8. **A. metallicum** Gerst., ibid. 243. Florida.

Digitized by Google

9. **A. nigrum** Herbst, Käfer, vii, 122, pl. 108, f. 11 : Germar, Magazin, ii, 239 ; Gyll., Sch. Curc. i, 254.

10. **A. nodirostre** Gerst., Stett. Ent. Zeit., 1854, 241. Florida.

11. **A. œdorhynchum** Lec., Pr. Ac. Nat. Sc., Phila., 1858, 78. San Diego, California.

12. **A. pensylvanicum** Boh., Sch. Curc, v, 417. Pennsylvania.

13. **A. porcatum** Boh., ibid. v, 374.

14. **A. proclive** Lec., Pac. R. R. Expl. and Surveys, Ins. 53. California.

15. **A. protensum** Lec., ibid. 53. California.

16. **A. reconditum** Gyll., Sch. Curc. v, 432. Pennsylvania.

17. **A. rostrum** Say, Journ. Acad. Nat. Sc. Phila., v, 253 ; ed. Lec., ii, 316 ; Curc. p. 6; ed. Lec., i, 264 ; *A. Sayi*, Gyll., Sch. Curc. i, 252; Harris, Inj. Insects, ed. ult. (larva.) Seeds of *Baptisia leucantha.*

18. **A. segnipes** Say, Curc. p. 6 ; ed. Lec., i, 264. Seeds of *Tephrosia virginica*. Also in seeds of *Astragalus* according to Say.

19. **A. subglobosum** Gerst., Stett. Ent. Zeit., 1854, 248.

20. **A. troglodytes** Mann., Bull. Mosc., 1843, ii, 289. California.

21. **A. ventricosum** Lec., Proc. Acad. Nat. Sc. 1858, 78. Fort Yuma, California.

22. **A. vile** Gerst., Stett. Ent. Zeit., 1854, 249.

Species are known to me to infest the seeds of *Baptisia tinctoria, Phaseolus pauciflorus;* and in the Adirondack region of New York, I found a species in abundance on the leaves of the locust, *Robinia pseudacacia.* Say, on the authority of Dr. J. F. Melsheimer, mentions that *A. rostrum* is found on the same plant : Curc. p. 6, but the species collected by me is quite different.

Digitized by Google

APPENDIX I.

ADDITIONS AND CORRECTIONS.

p. 2. add; Pubescence long and sparse, head very convex, eyes protuberant............................ **4. bombifrons.**

4. **Rhinomacer bombifrons**, n. sp.

Of the same form as *R. pilosus*, but larger, black, with a slight metallic tinge, thinly pubescent with long but not coarse gray hair. Beak wider at base and tip, narrowest about the middle, slightly curved, smooth above, punctured at the sides, separated from the head by a very deep constriction. Head nearly twice as wide as long, very convex, coarsely and densely punctured; eyes very convex and prominent. Prothorax a little wider than long, rounded on the sides, strongly punctured, with a slight vestige of a smooth dorsal line. Elytra strongly, but not densely punctured, more finely punctured towards the tip. Antennæ piceous, 3–7 joints paler. Length 4 mm.; .16 inch.

British Columbia, one specimen. The head is also convex in *R. pilosus* and *comptus*; but to a much less extent; the other characters are quite different and the elytra are much less densely punctured.

p. 4. Change the table of *Auletes*, at follows:

Antennæ inserted near the middle of the beak.	2.
" " " " base " "	3.
2. Last joint of antennæ triangular pointed, as wide as the preceding; black coarsely punctured, thinly pubescent............................	1. **ater.**
Last joint of antennæ narrower than the preceding, obtuse; black finely punctured, thinly pubescent.	**nasalis.**
3. Bluish black, densely punctured, thinly pubescent,	2. **subcœruleus.**
Very small, brown, irregularly pubescent..........	3. **cassandræ.**

1–2. **Auletes nasalis.** n. sp.

Shining black, sparsely clothed with fine suberect hairs, beak nearly as long as the head and prothorax, rather broad, narrowest at the base of the antennæ, which are inserted in large lateral cavities, about ⅓ from the base; gradually wider towards the tip, scarcely punctured, with a longitudinal row of punctures each side from the tip nearly to the antennæ. Head transverse, punctured, with a smooth frontal space; eyes prominent. Prothorax wider than long, narrowed in front, rounded on the sides, not densely, but strongly punctured. Elytra rather densely and finely punctured. Antennæ black, 9th and 10th joints large, not transverse, 11th much smaller and narrower, triangular with rounded angles. Length 3 mm.; .12 inch.

California, west of San Diego; collected by Mr. Hardy and kindly given me by Dr. Sharp. The 9th and 10th joints of the antennæ are transverse

Digitized by Google

and the 11th longer and acute at tip in *A. ater:* and nearly the same in *A. subcæruleus:* in *A. cassandra* the last joint is more obtuse, and the club is rather less loosely formed.

p. 7. Change the table of *Rhynchites* as follows :

5.	Color black bronzed................................	**2. æneus.**
	" blue..	**3. mexicanus.**
	" golden, tinged with green...................	**eximius.**

3–4. **Rhynchites eximius,** n. sp.

Bright golden, tinged with green and red, clothed with erect black hairs, which are shorter than in the two species above named, beak as long as the head and prothorax, slightly broader at tip, rather stout, slightly curved, rugose, bisulcate and feebly carinate behind the antennæ; lateral edges sharply defined; an elongate fovea between the antennæ. Head finely transversely rugose behind, sparsely and strongly punctured in front, not channeled. Prothorax about as wide as long, somewhat narrowed in front, rounded on the sides, sparsely and strongly punctured; tip constricted at the sides, base distinctly margined. Elytra nearly one-half wider than the prothorax, striæ composed of deep punctures, which are not much larger than those of the interspaces. Under surface, legs and beak, dark metallic green. Antennæ black, inserted about the middle of the length of the beak and extending beyond the base of the elytra. Length 3.7 mm.; .15 inch.

New Mexico, Dr. Horn. A very distinct species.

p. 96. **Phacepholis elegans.** I have three specimens from New Mexico, agreeing in all respects with the others, except that the scales are dirty gray, not at all metallic.

p. 80. **Dirotognathus sordidus.** Specimens collected by Mr. Crotch, at Lake Labache, British Columbia, are of smaller size (3–2 mm.; .125 inch), and the prothorax is somewhat broader than in the Mohave and Arizona specimens, but do not differ otherwise.

p. 114. in table of *Sitones*, add in 3 :

Elytra nearly uniform gray-brown, form less elongate,
bristles longer; prothorax with three paler stripes..... **hispidulus.**

4–5. **Sitones hispidulus** Germ., Sch. Curc. ii. 123; Allard, Ann. Ent. Fr., 1864, 376; *S. hæmorrhoidalis*, Sch., Curc. ii. 115.

This common European species occurred abundantly at the sea-shore near Long Branch, New Jersey, in July, about the roots of grass growing on the dunes. It is easily known by the long bristles of the elytra, which in our specimens are only slightly variegated in color.

p. 119, to table of *Trichalophus* add :

Beak, channeled....................................	**5. simplex.**
Beak flat, not at all channeled.....................	**6. planirostris.**

6. **Trichalophus planirostris,** n. sp.

Brownish-black, clothed with pale brown prostrate hairs. Beak not chan-

Digitized by Google

neled, but flat, or even feebly concave longitudinally; lateral grooves in front of the eyes triangular, feeble, short. Prothorax rounded on the sides, not constricted at tip, convex finely and densely punctured, with a very faint narrow dorsal line, with a paler lateral stripe, as in *T. simplex*. Elytra densely and finely punctured, without striæ, but tesselated in the usual manner with darker spots. Length 8.6 mm.; .33 inch.

Colorado; one specimen kindly sent to me by Prof. F H. Snow, by whom it was collected while in charge of the Kansas University Scientific Expedition of 1876. This species exactly resembles *T. simplex*, except in the absence of the well marked medial groove on the upper surface of the beak.

p. 124, to end of table of *Phytonomus* add in 5:

Scales golden-yellow, elytra with conspicuous black spots, sides of prothorax rounded............................ **eximius**.

4–5. **Phytonomus eximius**, n. sp.

Of the same size and form as *P. comptus*, black, prothorax and elytra densely clothed with golden-yellow scales, elytra with many small quadrate spots of black scales. Head and beak densely punctured, scales dense upon the occiput, gradually thinner in front, so that the beak becomes free from scales, but sparsely pilose with long bristles; frontal groove very short between the eyes, which are not prominent.

Prothorax as long as wide, truncate at tip, broadly rounded at base, sides parallel for half the length, then obliquely narrowed to the tip, which is impressed on the sides, but not on the upper surface; there are two ill-defined approximate basal black spots. Scutellum yellow, scaly. Elytra fully one-half wider than the prothorax, humeri oblique, obtusely angulated; sides parallel for two-thirds the length, then obliquely rounded to the tip; striæ fine, well marked, distinctly punctured, interspaces flat, without rows of bristles, under surface covered with paler scales, legs black, thinly clothed with pale hairs, thighs with a spot of pale scales. The antennæ are black and extend to the base of the prothorax; the first joint of funicle large, conical, as long as the three following united; 2–7 equal in length, but increasing rapidly in breadth, and united not longer than the club, which is elongate-oval and pointed at tip. Length 4.5 mm.; .18 inch.

Topeka, Kansas; Mr. E A. Popenoe. I have seen two specimens of this very pretty species, one of which has been kindly placed in my collection. It differs from *P. comptus* not only by the color but by the first joint of the funicle being large and the second not longer than the following; the funicle is also thicker and the club larger than in that species.

The scales in this species are deeply cleft almost to the base. Since the printing of that part of this memoir which relates to the present genus, I have examined more closely the scales of the different species in our fauna with the following result:

A. Scales thick, truncate, or very feebly emarginate at tip, with the angles not prominent.

Digitized by Google

a. Scales scarcely striate, nearly uniform; *comptus*, *eximius*.

b. Scales distinctly striate, with longer narrow ones intermixed, which are the bristles of the elytral interspaces. These bristles are obtuse in *quadricollis*, but acute in the European *rumicis*.

B. Scales elongate, striate, truncate and slightly emarginate at tip, *opimus*.

C. Scales elongate, striate, acutely and deeply emarginate at tip, with the angles acute prolonged; *setigerus*. In the European *Pollux* the scales are less deeply emarginate. The bristles are similarly striate, but longer and acute.

D. Scales narrow, cleft, with slender, acute lobes; bristles longer, acute and simple.

a. Scales cleft for two-thirds the length, *pubicollis*.

b. Scales cleft nearly to the base; *elongatus*, *Castor*.

E. Pubescent, without intermixed scales, *nigrirostris*.

It is apparent therefore, that valuable characters may be found for the recognition of the species in this difficult genus, by the study of the form of the scales.

p. 155 add:

1. **Lixus pleuralis** Lec., Pr. Ac. Nat. Sc. Phila., 1858, 78.

This species has a slender form, and is clothed with rather coarse grayish pubescence, with a stripe of paler color at the sides of the prothorax and elytra. The beak is cylindrical, rather stout, about twice as long as the head, punctured, carinate for one-half its length, without fovea between the antennæ; frontal groove short, deep, antennæ inserted one-fourth from the tip, black; funicle stout, first joint but little longer than the second, which is scarcely longer than the third. Prothorax one-third longer than wide, gradually narrowed from the base forwards, sides straight; punctures large, shallow, approximate, disc longitudinally broadly and somewhat deeply excavated towards the base; medial angle produced, obtusely rounded. Scutellum not visible. Elytra a little wider than the prothorax, sides rounded near the base, then converging behind, tips separately slightly prolonged, and acuminate; striæ composed of distant punctures, mostly concealed by the coarse pubescence. Length 7.6 mm.; .30 inch.

Arizona and Lower California. This species is as slender as *L. rubellus*, but the tips of the elytra are only slightly prolonged, and the other characters are quite different.

I neglected to mention that the third joint of the tarsi in *L. pleuralis* and *texanus* is much less broadly dilated, and the lobes are less obtusely rounded than in the species of division C. The lobes therefore envelop more closely the base of the fourth joint, thus showing a transition from *Cleonus* to *Lixus*, which would probably warrant the separation of these species as a distinct genus.

The first part of the table might be modified to indicate this difference, which is better than the characters I have used on p. 154.

Digitized by Google

Tarsi with the third joint less broadly dilated; cushions narrow, imperfect on the first and second joints.. 2.
C. Tarsi with the third joint very broadly dilated and more deeply bilobed; cushions of under surface complete 3.
2. A. Beak cylindrical, carinate for part of the length:
Body very elongate, sides of prothorax straight, elytra acuminate at tip; pubescence coarse and dense...... 1. **pleuralis.**
Body less slender, pubescence short and fine, with longer hairs intermixed, scutellum distinct, tips of elytra acutely rounded............................ **mixtus.**
B. Beak stouter, less cylindrical, very indistinctly carinate.. 4.

1–2. **Lixus mixtus**, n. sp.

Elongate, not very slender, black, pruinose with very fine short gray pubescence, with longer suberect hairs intermixed. Beak rather stout, cylindrical, finely but strongly punctured, with a short longitudinal groove between the antennæ, and a deep frontal fovea; between these points it is distinctly carinate; thinly pubescent, with suberect hair, nearly naked at the tip. Head punctulate, with scattered larger punctures which extend upon the basal part of the beak; antennæ inserted one-third from the tip, black, funicle as in *L. pleuralis*. Prothorax scarcely longer than wide, narrowed from the base forward and rounded at the sides, convex, bisinuate at base, medial lobe broad, prolonged, obtusely angulated; disc densely punctulate, with large shallow punctures not densely placed; vaguely and broadly longitudinally impressed from the middle to the base: there is a broad lateral stripe, and two indistinct dorsal ones of denser gray hair. Scutellum small, but distinct. Elytra separately rounded at the base, the curvature being continued to the sides, so that the humeral angles are indistinct, sides parallel, rounded behind; tips separately acutely rounded, with a small tuft of hair which gives them the appearance of being subacuminate; broadly impressed near the base, which causes the basal margin to become obtusely elevated; striæ composed of distant round punctures; sides with a broad stripe of denser pubescence. Beneath clothed with gray pubescence, coarsely and sparsely punctured. Length 10 mm.; .40 inch.

Colorado, one specimen, which I owe to the kindness of Mr. B. D. Smith. At first sight this species greatly resembles *L. placidus* (p. 159), but the characters are very different.

p. 154 in tables of *Lixus* modify No. 11 as follows:
11. Scutellar angle of prothorax very obtuse.......... 11′.
" " " produced, acute, basal excavation small, deep....................... **fossus.**
11′. Prothorax with shallower punctures.............. 8. **punctinasus.**
" " few deep " ; (smaller).... 9. **parcus.**

7–8. **Lixus fossus**, n. sp.

Black, pruinose with cinereous very short hair, and mottled with small

Digitized by Google

spots of longer whitish hair. Head and beak as in *L. punctinasus*, densely rather finely punctured; beak as long as the prothorax, rather stout, channeled between the antennæ, then obsoletely carinate to the frontal fovea; thinly pubescent. Prothorax a little longer than wide, gradually narrowed from base to tip, very feebly rounded on the sides, base slightly oblique each side, medial angle prolonged, acute; disc densely rugosely punctulate, with scattered larger punctures; basal excavation small and deep. Elytra scarcely wider than the base of the prothorax, but slightly rounded near the base; tips separately acutely rounded; basal impressions shallow, striæ composed of distant round punctures. Antennæ brown, inserted one-third from the tip. Length 8.5 mm.; .35 inch.

Enterprise, Florida, one specimen; Messrs. Hubbard and Schwarz. Easily known by the small deep prothoracic excavation and the acute scutellar lobe.

Another specimen from Florida agrees in form and sculpture, but differs by the beak more finely punctured, or rather punctulate, shining, and very slightly pubescent. The basal excavation of the prothorax is larger, less deep and vaguely channeled; the medial angle is equally acute and prolonged. The elytra are separately but more obtusely rounded at tip. I think this is the ♀ corresponding to the ♂ above described.

p. 158, in next to last line dele *L. calandroides* as a synonym of *Lixus musculus*, and add on page 158:

12. **Cleonus calandroides**; *Lixus cal.* Randall, Bost. Journ. Nat. Hist. ii, 42.

Massachusetts. By the kindness of Mr. E. P. Austin, two specimens of this species were recently sent to me. On examination I found to my great surprise, that it is a species of *Cleonus* closely allied to *vittatus* and *sparsus*, but differing by the beak more finely punctured, and the elytra clothed with uniform, finer, gray pubescence. The antennæ are much stouter than in *Lixus*, and the first and second joints of the hind tarsi are not spongy beneath. Length 9.5 mm.; .375 inch.

p. 176. The last paragraph under 1. *Endalus setosus* belongs to 3. *E. limatulus*.

p. 192, add.

2. **Magdalis subtinctus**, n. sp.

Black, subopaque, elytra with a blue reflection. Beak shining, sparsely punctured, head opaque, sparsely and finely punctured. Prothorax coarsely and densely punctured, about as wide as long, angle near the tip acute prominent, sides then sinuate to the basal angles which are acute and prominent. Elytra convex, gradually slightly wider behind, striæ strongly punctured, interspaces very finely and densely rugose, almost alutaceous. Thighs with a small acute tooth, claws distinctly toothed near the base. Length 4 mm.; .15 inch.

California, found by Mr. Crotch at Gilroy; related to *M. gracilis*, but the eyes are smaller and more flat, and the sides of the prothorax more

Digitized by Google

broadly sinuate behind the postapical angle, widest at the middle, and the hind angles are prolonged.

3. **Magdalis hispoides,** n. sp.

Elongate, cuneiform, deep black, somewhat shining, beak as long as the prothorax, slightly curved, strongly, but not densely punctured; head similarly punctured, eyes large, slightly convex. Antennæ inserted above the middle of the beak. Prothorax a little longer than wide, narrowed from the base forward, sides nearly straight, not toothed, slightly constricted near the tip; hind angles not produced; disc densely, moderately, coarsely punctured. Elytra with striæ not impressed, but composed of approximate quadrate punctures; interspaces as wide as the striæ, each with a row of well marked approximate punctures, thighs not toothed, claws simple. Length 3. 5 mm.; .14 inch.

British Columbia, one specimen, Mr. Crotch. Resembles a small narrow *Microrhopala* in appearance.

4. **Magdalis gentilis,** n. sp.

Elongate, black, with a bluish tinge on the elytra, beak as long as the prothorax, curved, finely punctured. Head opaque, sparsely punctulate, antennæ inserted about the middle of the beak. Prothorax a little longer than wide, sides parallel from the base for nearly one half the length, then rounded to the tip, which is tubularly constricted; hind angles not produced; disc densely, but not coarsely punctured. Elytra with striæ composed of approximate punctures, interspaces feebly convex, wider than the striæ, subopaque, finely reticulate, and marked with small rugose punctures. Thighs armed with a large acute tooth, claws not toothed. Length 4 mm.; .16 inch.

California, two specimens found at Lake Tahoe, by Mr. Crotch. Resembles in appearance *M. subtinctus* and *gracilis*, but differs by the form of the prothorax, and the simple claws.

p. 222. After *Notolomus bicolor* add.

1–2. **Notolomus myricæ,** n. sp.

Of the same size, form and color as the large form of *N. bicolor*, but the beak is more strongly and densely punctured. The prothorax is very finely, almost imperceptibly pubescent, more coarsely punctured, with the sides and two small apical spots testaceous: the lateral cusp is prominent as in *N. bicolor*. Elytra with striæ composed of larger punctures; the dark markings are very distinct, and quite different in pattern: there is a cloudy and ill-defined spot behind the scutellum: then an oblique band formed by elongate spots on the 2d, 4th, 6th and 8th interspaces; then a large apical blotch, occupying one-half the surface, with an oblique anterior outline, parallel with the oblique band; the pale color extends into this blotch along the 4th interspace for some distance; this dark blotch includes some small spots of lighter brown, and is also paler at the sides, along which it extends. Antennæ with the 2d joint of the funicle longer than the 3d. Length 2.1 mm.; .08 inch.

New Smyrna, Florida: one ♂ kindly sent me by Mr. E. A. Schwarz, who informs me that it is found on a species of myrtle, and is very rare.

Digitized by Google

p. 225. Modify the table of *Conotrachelus* as follows:

2. Prothorax not sulcate, usually carinate :......................... I.

(A. Beak rather stout, curved, thighs bidentate..................

B. Beak slender, very long, thighs unidentate....................

C. Beak rather stout, curved, thighs unidentate)................

Division I,—A will remain as defined, but in p. 229 to *C. nivosus* must be added as a synonym *C. figuratus*, p. 233, which is only a poorly developed ♂ in which the denticle of the thighs has almost become obsolete, thus causing them to appear unidentate.

Division I,—B will contain the species in *a* and *b* of the table, on p. 229; viz.: *cratægi*, *adspersus*, *similis*, *naso*, and

11–12. **Conotrachelus Belfragei**, n. sp.

Of the same form as *C. similis*, but much smaller; brown, clothed with brown and fulvous pubescent with a very large white spot each side of the prothorax, and another saddle-shaped one behind the middle of the elytra. Head densely clothed with fulvous pubescence; beak half as long as the body, slender, very slightly curved, shining, sparsely punctured, substriate and more coarsely punctured on the sides near the base, antennæ inserted about the middle. Prothorax wider than long, sides nearly parallel from the base for one-half the length; then rounded and obliquely narrowed to the tip; disc densely and coarsely punctured, with a few white hairs on the medial line, and a very large spot of white pubescence extending from the sides over two-thirds of the surface; this spot has two narrow prolongations, the anterior one oblique and reaching the apex, the other transverse, nearly attaining the median line. Elytra one-half wider than the prothorax at base, humeri slightly oblique, angulated, but not dentate, sides converging behind from the humeral angles; striæ composed of very large and deep quadrate foveæ, almost contiguous, except where separated by elevated crests, of which the 3d interspace has one near the base, a very large one about the middle, and a smaller one behind the middle; the 5th, 7th and 9th interspaces are narrow and carinate, and on the 8th there is a small tubercle near the tip, clothed with white hair; there are besides two short lines of white pubescence at the base of each elytron. Under surface densely punctured, abdomen with three rows of white spots. Thighs with a broad white ring, and a large acute tooth. Length 4 mm.; .16 inch.

Texas, one specimen, Mr. Belfrage.

p. 247 to 2. *Pseudomus sedentarius* add.

A specimen was collected at Enterprise, Florida, and kindly sent me by Mr. E. A. Schwarz. It differs from *P. truncatus* not only by the thighs being unarmed, and by the elytral spot not being narrowed at the tip, but also by the form of body which is elongate and subfusiform, while in *P. truncatus* it is much stouter, with the prothorax broader than long, and much more narrowed in front. The prothorax and elytra are marked with several small spots of mixed yellow and white scales. Length 4.3 mm.; .17 inch.

p. 289. *Aulobaris anthracina*, transfer to *Pseudobaris* p. 297 and add.

The examination of a second specimen in better condition shows that the

Digitized by Google

claws are approximate and connate at base. It is therefore to be placed next to *P. nigrinus*, which has the pectoral groove deeper and more sharply defined than in the other species of *Pseudobaris*. I observe a few white scales at the base of the third interspace, which represent the more conspicuous spot seen in the others.

1–2 **Pseudobaris pectoralis**, n. sp.

Black, not very shining, oval, subelongate. Beak as long as the prothorax, cylindrical, not stout, coarsely punctured on the sides, more sparsely and more finely above, separated from the head by a distinct constriction; head with a few small scattered punctures. Prothorax as wide at base as the length, rapidly obliquely narrowed in front, scarcely rounded on the sides, moderately constricted near the tip; base with the scutellar lobe broad and obtusely rounded; disc coarsely punctured, more densely and somewhat confluently at the sides; dorsal line indistinct. Elytra with deep, indistinctly punctured striæ; interspaces a little wider than the striæ, each with a single row of large, deep punctures. Beneath coarsely punctured; punctures becoming smaller, but not more distant upon the abdomen. Prosternum with a broad, deep groove in front of the coxæ, limited by parallel acute ridges; claws small, connate at base. Length 4.4 mm.; .175 inch.

New Smyrna, Florida; one specimen, Mr. E. A. Schwarz. This species is related to *P. anthracina*, but differs by the prothorax more obliquely narrowed in front, and less rounded on the sides, and by the deep punctures of the interspaces of the elytra.

p. 298. Change *P. angusta* to *angustula*; the former name being preoccupied in *Baris*. The pectoral groove is deep and sharply defined as in *P. nigrina*.

p. 303, add.

2. **Stethobaris corpulentus**, n. sp.

Larger, broader and more convex than *S. tubulatus*, shining black. Beak long, curved, not very slender, sparsely, finely punctured above, more coarsely at the sides, separated from the head by an indistinct constriction; head sparsely and finely punctured. Prothorax much broader than long, very much rounded on the sides, and narrowed in front, strongly tubularly constricted near the tip; disc sparsely and not coarsely punctured; basal lobe broad, short, truncate. Elytra gradually wider for a short distance, and forming an obtuse angle with the rounded sides of the prothorax, then obliquely narrowed and rounded, entirely covering the pygidium; striæ very deep, impunctured; interspaces wider than the striæ, with a few scarcely perceptible punctures. Beneath coarsely punctured; third and fourth ventral segments with a single transverse row of punctures; fifth densely, more finely punctured. Prosternum with a broad groove, distinctly limited by acute ridges. Length 3.4 mm.; .13 inch.

Tampa, Florida; one specimen, Mr. E. A. Schwarz.

p. 303. The table of *Microcholus* should read:

Prothorax punctured; constriction near the tip.

Digitized by Google

Elytra deeply striate..	1. **striatus.**
" finely striate..................................	2. **puncticollis.**
Prothorax smooth, constriction much deeper and distant from the tip....................................	3. **lævicollis.**

p. 308, make the following changes in the table of *Centrinus*, division C :

8. Prothorax very densely punctured; scales yellowish...	20. **falsus.**
" less " "	8′.
8′. Pubescence white, scale-like........................	**canus.**
" yellowish, fine and capillary.............	21. **longulus.**

20–21. **Centrinus canus**, n. sp.

Elongate, rather depressed, black, shining, tolerably densely clothed with small, whitish scales. Beak as long as the head and prothorax, slender, slightly curved, smooth and polished, punctured only at the base. Head finely punctured, frontal impression distinct. Prothorax scarcely longer than wide, gradually slightly narrowed from the base for more than half the length, then rounded, and more suddenly narrowed to the tip, where it is feebly constricted; strongly and rather densely, but not confluently punctured, with a narrow, smooth dorsal line. Elytra a little wider near the base, then very slightly narrowed; conjointly rounded at tip, striæ deep, interspaces flat, rugosely punctulate, with the scales not arranged in rows. Prosternum transversely impressed as usual, and longitudinally concave; apical part with a small fovea; hind margin not emarginate; front coxæ widely separated; fifth ventral segment longer than the fourth. Funicle of antennæ slender; first joint as long as the second and third united; second twice as long as the third. Length 4.7 mm.; .18 inch.

Enterprise, Florida; one specimen, Mr. E. A. Schwarz.

On p. 317, add.

2. **Centrinus strigatus**, n. sp.

Elongate, parallel, brownish black, thinly pubescent with yellowish hairs. Beak cylindrical, rather slender, curved, as long as the head and prothorax, dark brown, shining, sparsely and finely punctured. Head sparsely punctulate. Prothorax scarcely wider than long; sides nearly parallel for half the length, then rounded and obliquely narrowed to the tip, which is strongly constricted; surface deeply, coarsely and confluently punctured; the intervals between the punctures form longitudinal plicæ, as in *Onychobaris rugicollis*, but finer; medial line smoothly elevated, extending nearly to the tip and base. Elytra not at all wider than the base of the prothorax, parallel on the sides for two-thirds the length, then obliquely narrowed to the tips, which are very broadly conjointly rounded, and seem almost truncate, though the pygidium is entirely concealed; striæ deep, finely punctured; interspaces a little wider than the striæ, with single rows of deep punctures, which bear small, reclinate yellow hairs. Beneath strongly punctured. Prosternum deeply, transversely impressed, not foveate; front coxæ widely separated; metathoracic episterna narrower than

Digitized by Google

usual; fifth ventral segment as long as the third and fourth united. Antennæ with the first joint of the funicle elongate; second not longer than the third. Length 4.8 mm.; .17 inch.

Colorado; one specimen, Mr. B. D. Smith. This remarkable species does not seem related to any other in our fauna by form or sculpture.

p. 818, add.

8. **Zygobaris? convexus**, n. sp.

Less robust, but more convex, shining black (sparsely clothed with white scales?) Beak slender, slightly curved, as long as head and prothorax, punctured towards the base, smooth towards the tip; basal transverse impression distinct. Head sparsely punctulate. Prothorax not wider than long, much rounded on the sides, narrowed and constricted in front, deeply and coarsely punctured, with a smooth, dorsal line, and an indistinct smooth space each side half way towards the sides. Elytra suddenly wider at base than the prothorax; humeri obtusely rounded, sides converging behind; striæ deep, impunctured, interspaces a little wider than the striæ, flat, each with a single row of very small punctures, which probably bore white scales. Beneath strongly punctured, thinly pubescent, prosternum flat, not transversely impressed nor foveate; front coxæ not very widely separated. Funicle of antennæ stout; first joint elongate; second not longer than third. Length 2.4 mm.; .10 inch.

Enterprise, Florida; one specimen, Mr E. A. Schwarz. The scales have been removed by abrasion, and only a few remain near the base of the elytra, and the sides and base of the prothorax. The apical constriction of the prothorax does not continue across the prosternum as in the other species, and as in all *Centrinus* known to me, but disappears in the apical margin, thus leaving the front part of the prosternum flat. This should probably be considered a generic difference, but I am unwilling to separate it without having better preserved specimens for study. The claws seem to be very small, but hardly connate at base.

p. 819, add.

2. **Barilepton lineare**, n. sp.

Elongate, black, clothed with small, dirt-colored scales, which on the elytra are scarcely wider than long, obovate, and broadly subtruncate. Beak stouter than *B. filiforme*, and more coarsely punctured at base. Prothorax densely and deeply, though not very coarsely punctured, with a narrow, smooth, dorsal line. Elytra a little wider than the prothorax at the base, striate and punctured as in *B. filiforme*. Length 3 8 mm.; .15 inch.

Sumter County, Florida; one specimen, Messrs. Hubbard and Schwarz. Differs from *B. filiforme* by the larger size, the punctuation of the prothorax and the form of the scales of the elytra; the elytra are also evidently, though but slightly wider than the base of the prothorax, and the sides of the latter are suddenly rounded in front of the middle.

3. **Barilepton cribricolle**, n. sp.

Of the same size and form as *B. lineare*, but clothed with elongate, white

Digitized by Google

scales, which form white lateral vittæ on the prothorax, and discoidal lines on the elytra. Black, beak stout, curved, punctured at base, smooth towards the tip. Prothorax more coarsely but less densely punctured, almost cribrate, sides nearly parallel, rounded behind and obliquely narrowed in front of the middle; dorsal line distinct. Elytra suddenly and more distinctly wider than the prothorax at base; striæ narrow, deep, impunctured, interspaces more strongly punctured, white scales denser on the second interval for four-fifths the length; upon the fourth there is a short basal line, then a long line extending from one-fourth of the length to three quarters; on the sixth a basal line extending to one-fourth of the length. Beneath strongly punctured, thinly clothed with white scales, metathoracic episterna and spots on third, fourth and fifth ventral segments densely scaly; the scales are also gradually more dense on the sides of the first and second ventral segments. Length 3.8 mm.; .15 inch.

Enterprise, Florida; one specimen, Mr. E. A. Schwarz.

4. **Barilepton quadricolle**, n. sp.

Very narrow, linear, black, clothed with elongate small whitish scales, beak less stout, punctured at base, smooth at tip. Prothorax as long as wide, sides parallel behind, suddenly rounded and narrowed in front of the middle; strongly and rather densely punctured; dorsal line smooth, distinct, scales more dense at the sides. Elytra suddenly a little wider than the base of the prothorax; striæ narrow, deep, impunctured, interspaces finely punctured, beneath strongly punctured, thinly clothed with small whitish scales. Length 3.2 mm.; .13 inch.

Nebraska, one specimen; given me by Mr. Ulke. I confounded this species with *B. filiforme*, which it resembles in the form of the prothorax, but differs by the stronger punctuation and by the elytra being distinctly wider than the prothorax just behind the base; the scales are also whiter and larger, and the elytral striæ are deeper.

These four species may therefore be distinguished as follows:

Body very narrow, filiform, elytra not wider at base than the prothorax, which is densely but not deeply punctured, scales very small, gray, denser at the sides of prothorax and elytra.................... **1. filiforme.**

Body very narrow, prothorax strongly and densely punctured, suddenly narrowed in front, scales of elytra oval, whitish, not very small............. **4. quadricolle.**

Body linear, but less narrow, prothorax densely, less coarsely punctured; elytra a little wider than the prothorax at base, scales very small, rounded, yellow-gray .... **2. lineare.**

Body as in *lineare*, but the elytra are more conspicuously wider near the base, and the scales are elongate, white, and form stripes; prothorax more coarsely punctured....................................... **3. cribricolle.**

Digitized by Google

p. 330. in *Rhynchophorini* add :

A specimen of the well-known *Rhynchophorus palmarum* was collected by Mr. Hardy, in Southern California, west of San Diego, and kindly sent to me by Dr. David Sharp. As groves of palm trees are known at several places on the eastern slope of the Sierra in that region, it is not surprising that they should be depredated on by this species, which is widely diffused through the Antilles and tropical America.

Quid? Rhynchophorus noxius Gyll. Sch iv, 821. Perhaps an imported specimen of *R. palmarum.*

p. 331. Add the three following new species of *Sphenophorus;* the first belongs to Horn's group IV ; the others to V ; Proc. Am. Phil. Soc. xiii, 412.

Sphenophorus velutinus, n. sp.

Elongate, brownish black, entirely opaque and velvety in lustre. Beak shorter than the prothorax, curved, somewhat compressed, smooth ; antennæ inserted immediately in front of the eyes. Prothorax more than one-half longer than wide, oval, strongly tubulate in front ; the elevations are very vague and ill defined, the impressions are marked with shallow punctures ; sides more densely and more deeply punctured ; dorsal line narrow, slightly elevated, extending nearly to the base and apical constriction. Elytra not longer than the prothorax, narrowed behind from near the base ; striæ very fine, marked with a few distant small punctures ; two outer striæ with more numerous larger punctures ; interspaces flat, obsoletely punctulate. Pygidium with a few large deep punctures, beneath sparsely punctured. Front and middle tarsi with the third joint broadly dilated, spongy each side beneath ; third joint of hind tarsi slightly dilated, not wider than long. Length 11 mm. ; .43 inch.

One specimen, Florida. Very different from all others in our fauna.

Sphenophorus variolosus, n. sp.

Of the same general form as *S. arizonensis,* black, somewhat shining ; beak shorter than the prothorax, slightly curved, strongly punctured at base, nearly smooth at tip, which is moderately compressed. Antennæ inserted immediately in front of the eyes ; head finely and sparsely punctured with a large frontal fovea prolonged anteriorly in a channel which extends as far as the beginning of the narrow part of the beak. Prothorax oblong, longer than wide, sides strongly rounded in front, and tubulate at the apex ; impressions and elevations very vague, indicated by the presence of larger punctures in the places where the impressions should be, and of finer punctures on the elevations ; there is a group of large punctures just behind the tubular constriction, and behind these punctures there is a smooth dorsal line extending nearly to the base. Elytra with fine deeply impressed striæ, along which are placed at irregular intervals very large shallow pits, through which the striæ run, producing a very curious appearance ; interspaces finely sparsely punctulate, not elevated ; the punctures of the outer striæ are smaller and deeper ; those of the next

Digitized by Google

are quadrate and confluent. Pygidium coarsely punctured; beneath shining, sparsely punctured; more coarsely on the 5th ventral, which is impressed near the tip; flanks of prothorax and middle of abdomen nearly smooth. Third joint of tarsi scarsely broader than second, glabrous beneath, fringed only at the sides. Length 9.7 mm.; .38 inch.

Colorado, one specimen, Mr. B. D. Smith. The presence of the post-apical group of large punctures on the prothorax affiliates this species to *C. placidus*, which however it does not otherwise resemble.

Sphenophorus oblitus, n. sp.

Of the same general form as *S. placidus*, black, covered with a dirt-colored crust. Beak two-thirds the length of the prothorax, stout, slightly curved, more strongly compressed at tip; punctured at base, smooth at tip; frontal groove deeply excavated, extending to the base of the narrow part of the beak. Antennæ inserted just in front of the eyes. Prothorax more than one-half wider than long, sides parallel for two-thirds the length, then gradually and obliquely narrowed to the tip, which is less strongly tubulate than usual; surface covered with large, shallow punctures, with the depressions very feebly indicated: the punctures just behind the constriction are a little denser at the middle, representing thereby the small impression which is distinct in *S placidus*, and nearly obsolete in *S. variolosus*; there is no smooth dorsal line. Elytra with fine striæ, very feebly punctured; interspaces with single rows of very fine punctures, alternately a little wider and more elevated. Pygidium sparsely and deeply punctured. Beneath coarsely punctured on the flanks of the prothorax; punctures smaller and distant at the middle of the abdomen; fifth ventral sparsely and very deeply cribrate. Thighs sparsely and rather feebly punctured; front tibiæ distinctly sinuate on the inner side, but not angulate; tarsi with the third joint not dilated, glabrous beneath, fringed only at the sides. Length 9.6 mm.; .38 inch.

Texas; one specimen, Mr. G. W. Belfrage. This is also to be placed near *placidus*, to which it has but little resemblance. It also shows a tendency towards the *compressirostris* form, in which, however, the beak is not curved, and the front tibiæ are strongly angulated on the inner side.

Sphenophorus cariosus Oliv., Ent. v, 83, 91, pl. 28, 415; Horn, Pr. Am. Phil. Soc. 1873, 420, cum. synon.

Dr. Horn has suggested to me that this species and *S. callosus* Oliv., should be united. After careful examination of the specimens in my collection, I think this view is correct. Those who are inclined to adopt it will place *callosus* as the synonym, since it is represented by old and abraded specimens.

Sphenophorus sculptilis Uhler, Proc. Acad. Nat. Sc. Phil. 1855, 416; Horn, l. c. 424.

With this species should be united as a synonym *S. Zeæ* Walsh, Practical Entomologist, ii, 117; Riley, Missouri Ent. Report, iii (1871), 59, fig. 22.

Digitized by Google

p. 331 add the following new genus:

TRICHISCHIUS n. g.

This genus is founded upon one species, which agrees with *Sphenophorus*, except in the following characters:

The inner side of the front and middle coxæ and the middle of the metasternum and the first and second ventral segments are clothed with long hair; the thighs beneath, and the tibiæ on the inner side are fringed with long hair; the genital segment of the ♂ projects (as in *Rhynchophorus*) and is fringed with hair at the tip. The third joint of all the tarsi is slender, not at all dilated or emarginate, glabrous beneath, fringed at the sides, and quite as long as the second joint, which is equal to the first.

The prothorax is uniformly punctured, without impressions, but with a narrow, smooth dorsal line, and the elytral striæ are deep and crenate; the interspaces are even, and scarcely punctulate.

1. T. **crenatus**, n. sp.

Black, subopaque. Beak scarcely more than half the length of the prothorax, slender, slightly curvéd, finely punctured, with a very fine longitudinal impressed line near the base, which terminates in a small, frontal fovea. Prothorax nearly one-half wider than long, narrowed in front of the middle, and rounded on the sides, tubularly constricted near the tip; base nearly truncate with the edge acute, and sparsely fringed with yellow hairs; disc rather densely but not coarsely punctured, more coarsely towards the base, each side of the medial line, where it is feebly impressed; dorsal line narrow, very distinct, slightly elevated near the base. Elytra at base a little wider than the prothorax, basal angles slightly projecting forwards; striæ deep, crenate, interspaces nearly flat, scarcely perceptibly punctulate; humeri reddish; pygidium with the hind part strongly, rather densely punctured; apex (♂) declivous, smooth, concave; genital plate prominent, smooth. Beneath shining, strongly but not densely punctured; punctures larger on the metasternum; side pieces narrow, parallel; prosternum very narrow between the coxæ. Length 8.8 mm.; .35 inch.

Colorado; one specimen, Mr. B. D. Smith.

p. 365, add as a synonym to

Tomicus pini; *T. pallipes* Sturm, Cat. 1826, p. 76; *T. dentatus* Sturm, ibid. pl. iv, f. 30. Say's name has priority by one year.

p. 357, add as a synonym to

Xyloterus bivitatus; *Apate rufitarsis* Kirby, Fauna Bor. Am. iv, 193.

p. 337, after *Gononotus* add

HIMATIUM Woll.

I would refer to this genus, which is fully described by Mr. Wollaston in Trans. Ent. Soc., London, 1868, 461, a small slender reddish-brown opaque Cossonide, thinly clothed with coarse hair.

It has all the characters given in the description, except that the hairs are not long, and the antennæ are not very pilose and the surface not shining. The more important ones may be recapitulated as follows:

Digitized by Google

Body narrow, linear, rather flat, sparsely pubescent. Beak parallel, cylindrical, separated from the front by a distinct impression; eyes rather large, transverse, coarsely granulated, situated on the sides and under surface of the head, not visible from above. Antennæ inserted about the middle of the beak, short and stout, scape attaining the eyes; funicle first joint large, 2–7 very short, closely connected, club small, oval, shining, sparsely hairy, annulated only at the tip. Metasternum rather long; front coxæ widely separated, the others still more distant; tibiæ with the terminal hook very large; tarsi rather short, third joint but little wider, somewhat bilobed.

The genus has thus far occurred only in Malabar, and *Pholidonotus*, which immediately follows it, is found in Borneo. It appears, therefore, to be a third instance of that remarkable distribution which I have previously mentioned in the Heteromerous genera *Othnius* and *Ischalia*.

1. **H. errans** n. sp.

Very elongate, reddish-brown, nearly opaque, thinly clothed with coarse yellowish hair. Beak a little shorter than the prothorax, rugosely punctured, transversely impressed at the base. Head finely punctured. Prothorax more than one-half longer than wide; widest near the base, sides suddenly rounded behind the widest part, but gradually obliquely narrowed in front and nearly straight; slightly constricted near the tip; disc rather flat, densely and coarsely punctured, without impressions or dorsal line. Elytra not wider than the widest part of the prothorax, truncate at base, scutellum not visible, sides parallel, rounded at tip; striæ deep and broad, punctures large, quadrate, interspaces very narrow. Body beneath very coarsely punctured; punctures of ventral segments not smaller. Length 2 mm.; .08 inch.

District of Columbia; collected by Mr. Ulke. I owe a specimen of this interesting species to the kindness of Dr. Horn.

Digitized by Google

APPENDIX II.

UNRECOGNIZED SPECIES.

1. **Rhynchites virdiæneus** Randall, Bost. Journ. Nat Hist., ii, 23.

R. corpore elongato viridi-æneo; capite subnigro, dense punctulato; rostro dilatato, supra utrinque sulcato; thorace æneo, dense et profunde punctulato; elytris viridi-æneis, seriebus vagis punctulatis; pedibus piceis.

Body elongated, brassy. Head darker, profoundly punctured; front somewhat depressed; rostrum dilated, especially at tip, which presents a tubercle on each side, an impressed line nearly the whole length on each side. Thorax brassy, densely and profoundly punctured. Elytra greenish brassy, with profound punctures disposed in irregular lines; feet inclining to piceous. Length about three-twentieths of an inch. Occured at Augusta (Maine), June. Perhaps allied to the *R. æratus* of Say, but the elytra of that insect are described as crenate-striate.

2. **Rhynchites congrua** Walker, Nat. in British Columbia by J. K. Lord, ii, 331.

Nigricante cyanea, aspere punctata; rostro thoracis longitudine, thoracis lateribus convexis; elytris latis, lateribus sub-convexis.

Blackish blue, roughly punctured. Rostrum as long as the thorax, slightly dilated towards the tip. Thorax narrowed in front, sides convex. Elytra much broader than the thorax and about twice its length; sides slightly convex. Length 3 lines.

Rhynchites humeralis Boh., Eugenies Resa, Ins. 117.

Oblongo-ovatus, modice convexus, niger tenuiter pubescens; antennis tibiisque ferrugineis; prothorace confertissime punctulato, lateribus parum ampliato; elytris crebre punctato-striatis, macula humerali rufo-testacea ornatis. Long, 2 mm.; lat. 1¼ mm.

Var. *a*: elytris rufo-ferrugineis dorso infuscatis.

If this species properly belongs to our fauna, it will be readily recognized without the aid of the long description which accompanies the above diagnosis.

3. **Polydrosus americanus** Gyll., Sch. Curc. ii, 136.

"Oblongus, niger opacus, cinereo-squamulosus, fuscoque pubescens; antennis tibiis tarsisque ferrugineis; thorace pulvinato, confertim punctato; elytris punctato-striatis, apice acuminatis, in dorso plagiatim nigro-variegatis. America borealis, ex musæo Dom. Com. Mannerheim, ad describendum, amice communicatus.

Parvus: *Sitona lineello* minor. Caput majusculum, subquadratum, supra planum, confertim punctulatum, nigrum, sat dense cinereo-squamulosum; oculi semi-globosi, nigro brunnei; rostrum capite paulo brevius et angustius, crassum, porrectum, angulatum, supra planum, anterius obsolete canaliculatum, punctatum, nigrum, squamulosum. Antennæ longiusculæ, fer-

Digitized by Google

rugineæ, parce pilosæ. Thorax parvus, angustus, latitudine fere longior, basi apiceque truncatus, intra apicem late et profunde transversim impressus, margine alte elevato; lateribus parum ampliatus, supra convexus, pulvinatus, confertim punctatus, niger, sat dense cinereo-squamulosus et fusco-pubescens. Scutellum parvum, rotundatum, nigrum. Elytra antice truncata, thoracis basi duplo latiora, humeris elevatis, fere rectangulatis; lateribus non ampliata, posterius attenuata, apice conjunctim acuminata, thorace quintuplo longiora, supra in dorso antico parum convexa, punctato-striata, interstitiis planis, subtiliter alutaceis; nigra, fusco-pubescentia, squamulis cinereo-albidis, inæqualiter vestita, relictis nempe in dorso plagis variis difformibus, nudis, nigris. Corpus subtus punctatum, nigrum, densus cinereo-squamulosum. Pedes mediocres, ferruginei, femoribus clavatis, muticis, extrorsum nigro-piceis."

Dr. Horn thinks that it may be *Cyphomimus dorsalis*. If it be not referable to that species it is unknown to us, and renewed examination of the type will be necessary to confirm the correctness of the generic position.

4. **Barynotus granulatus** Say, Curc. 12; Lec, ed. i, 278.

Brown, thorax obtusely granulated, with a pale vitta.

Inhabits Indiana. Body dull brown, with short raised hairs; head impressed between the eyes. Thorax with very obtuse granulations, a longitudinal, slender, impressed dorsal line in a dull yellowish vitta. Elytra a little elevated on the basal edge; striæ concave, much dilated, punctured; punctures wide, not very deeply impressed, interstitial lines not so wide as the striæ, with hairs; suture a little pale. Length about one-fourth of an inch.

The surface of the thorax exhibits the appearance of obtuse little elevated granulations, and the profile view shows irregular punctures or interrupted rugæ.

5. **Byrsopages carinatus** Motsch., Schrenk's Reisen, Amur. Ins. 168.

Closely allied to *B. ventricosus* Motsch., ibid., and distinguished only by the gray fasciculated pubescence which clothes the elytra, causing them to appear spotted; by very slightly elevated ridges, which seem to replace the striæ of the elytra, and by the head more strongly punctured; the latter is reddish, as are also the antennæ and legs; the teeth and the spines at the tip of the tibæ are longer and more distinct; the under surface of the body redder and less glabrous; punctuation not dense but very obvious, and pubescence more developed. Length 4 lines.

I have condensed this translation from the remarks in the work cited. The genus is unknown to me and is placed by Lacordaire near *Homalorhinus*.

6. **Leposoma californica** Motsch., Bull. Mosc. 1845, ii, 105.

Elongato-ovata, convexa, punctatissima, pilosa, brunnea, fusco-cinereo squamosa; antennis tarsisque testaceo-rufis; elytris punctato-striatis. Long. 2½ lin; lat. 1 lin.

California. Neither the generic nor specific description permits its identification.

Digitized by Google

7. **Phytonomus trivittatus** Say, Curc. 12 ; ed. Lec., i, 273.

Blackish brown, with numerous scale-like hairs.

Inhabits North-west Territory. Body blackish brown, with numerous robust hairs almost resembling scales, which are longer in three yellowish metallic thoracic vittæ, of which the lateral ones are broader and terminate in a spot on the humerus; the vittæ and spot are pale brownish cinereous ; antennæ rufous ; elytra with large costal spots, interstital lines obsoletely alternating with blackish and pale brown cinereous. Thighs beneath near the tip emarginate ; anterior tibiæ a little incurved at tip. Length one-fifth of an inch.

8. **Hylobius stupidus** Boh., Sch. Curc. i, 339.

Oblongus, niger, opacus, antennis pedibusque nigro-piceis, capite crebre rugoso, thorace subtiliter rugoso-punctato, carinato, elytris obsolete punctato-striatis, interstitiis confertim granulatis.

Habitat in Georgia, Americes septentrionalis. Dom. Hooker ; Mus. Schh. Magnitudo fere *H. pineti*, sed minus convexus. Caput magnum, crassum, supra convexum, nigrum obscurum, crebre ruguloso-exasperatum ; oculi oblongi, depressi, obscure brunnei ; rostrum capite dimidio longius et angustius, deflexum, crassum, parum arcuatum versus apicem nonnihil ampliatum, nigrum opacum, crebre rugoso-punctatum, carinula media obsoleta notatum. Antennæ capite cum rostro fere breviores, paulo pone medium rostri insertæ, crassæ, nigro-piceæ, griseo-pilosæ, clava ovata, acuminata. Thorax latitudine media multo longior, apice truncatus, anterius nonnihil angustior, coarctatus, lateribus in medio nonnihil rotundato-ampliatus, basi leviter sub-bisinuatus, supra parum convexus ; totus niger opacus, crebre sed non profunde rugulosus, pilis rigidis depressis flavescentibus, parce adspersus, in medio dorsi carinula abbreviata, sat distincta. Scutellum subtriangulare nigrum opacum. Elytra basi subtruncata antice thoracis basi paulo latiora, et illo triplo longiora, humeris antrorsum prominulis, obtuse angulatis, lateribus inflexa, pone humeros nonnihil ampliata, dein apicem versus sensim angustata, apice ipso conjunctim obtuse rotundata, ante apicem callo vel gibbere notata ; supra modice convexa, nigra opaca, striis parum profundis, angustis, obsolete punctatis, pulvere cinereo repletis exarata, interstitiis latis planis, confertissime subtiliter granulatis, setulis brevissimis pallidis depressis parce adspersa. Corpus subtus nigrum obscurum, setulis flavescentibus discretis adspersum, pectore fortius, ventre tenue punctulatis. Pedes longiusculi, validi, nigro-picei, flavescenti pilosi ; femoribus incrassatis, remote punctatis, omnibus dente crasso valido acuminato armatis ; tibiis subcompressis, rude rugoso-punctatis, intus ante medium ampliatis, subdentatis apice uncinatis ; tarsis elongatis dilutius piceis, subtus fulvo-spongiosis.

9. **Hylobius assimilis** Boh., Sch. Curc. ii, 345.

Oblongus, niger, capite profunde remote punctato, rostro obsolete carinato, thorace angustiore, antice valde coarctato, punctato-rugoso, linea media lævi, elytris dorso fere planis, punctis oblongis striatis, interstitiis undique granulato-rugosis.

Habitat in America boreali, a Com. Dejean missus. Mus. Schh.

Digitized by Google

Statura fere *H. palis*, sed nonnihil major, capite remote punctato, thorace angustiore, ut et defectu signaturis elytrorum, ab illo mox distinctus. Caput breve, rotundatum, nigrum, sat profunde minus crebre punctatum; fronte foveola obsoleta impressa; oculi laterales oblongi, transversi, depressi, brunnei; rostrum longitudine thoracis, crassiusculum, teres, parum arcuatum, nigrum subnitidum, a basi ultra medium obsolete carinatum, inter antennas canalicula abbreviata insculptum, totum profunde, minus crebre rugoso-punctatum. Antennæ longe pone medium rostri insertæ, thorace paulo longiores, crassiusculæ nigro-piceæ, clava ovata subobtusa cinereo-pubescente. Thorax latitudine multo longiore, antice valde angustatus, coarctatus, lateribus paululum rotundatus, basi sub-bisinuatus, supra minus convexus, niger profunde rugoso-punctatus, in medio obsolete carinatus. Scutellum parvum, rotundatum, nigrum pallido-pubescens. Elytra antice thoracis basi paulo latiora, et quadruplo longiora, humeris subprominulis, rotundatis, lateribus inflexa, ultra medium linearia, tum apicem versus angustata, apice conjunctim obtuse rotundata, supra parum convexa dorso fere plana; tota nigra subopaca, striis minus latis, crebre cancellatis, exarata, quarum foveolæ oblongo-quadratæ, sat profundæ.

10. **Lixus præpotens** Boh., Sch. Curc. iii, 62. *Rhynchophorus præp.* Say, Curc. 21; ed. Lec., i, 287.

Thorax with three vittæ.

Inhabits Arkansas. Body black, covered with dense prostrate cinereous hairs. Rostrum shorter than the head and thorax; thorax with three black vittae, extended behind at the scutel. Elytra with double series of punctures; a black vitta on the middle of each, and a narrower subsutural one. Length more than three-fifths of an inch. This is a fine insect.

11. **Lixus poricollis** Mann., Bull. Mosc. 1843, ii, 291.

Oblongus, niger, pubi grisea dense obtectus, rostro breviore recto carinato, thorace antice parum angustiore, dorso punctis nigris remotis variolosis impresso, basis foveolato, longitudinaliter anguste carinato, utrinque nigrolineato, elytris subtiliter punctato-striatis, apice singulatum subacuminatis, fusco trilineatis, femoribus muticis. Longitudo cum rostro 4–5 lin.; latitudo 1¼–1½ lin.

California; Mus. Mosq. Ad Stirpis 2dæ manip. 1mum op. cel. Schönherr, adnumerandus.

12. **Lixus modestus** Mann., ibid.

Elongatus niger, griseo-pubescens, rostro crassiusculo, modice arcuato, thorace conico breviore, dorso longitudinaliter excavato, elytris striato-punctatis, dense cinereo-squamulosis, maculis minutis albescentibus remote aspersis, apice singulatim subacuminatis, femoribus muticis. Longitudo cum rostro 5 lin.; lat. 1 1-3 lin.

California; Mus. Mosq. Stirpis 2dæ manipulo 1mo operis cel. Schönherr collocandus.

13. **Lixus marginatus** Say, Curc. 13; ed Lec., i, 275; Boh., Sch Curc. iii, 70.

Digitized by Google

Black, covered with minute cinereous hairs, thorax impressed. Elytra, region of the scutel and middle of the base indented.

Inhabits United States. Body black, covered with short minute robust recurved hairs, punctured. Antennæ rufous, club dusky. Thorax a little convex each side, behind the middle of the side rectilinear; a little contracted before with an indented line above, more profound near the base, with dilated, confluent, slightly impressed punctures, not deeply sinuated at base, with regular series of punctures. Elytra, region of the scutel indented; abdomen dull fulvous behind. Length nearly seven-twentieths of an inch.

[This species is said to occur on the lower Mississippi and in the Atlantic States. I have not identified it, nor was it known to Gyllenhal, who merely cites Say.]

14. **Tychius aratus** Say, Curc. 26; ed. Lec., i, 294.

Body entirely covered with pale olivaceous, dense, elongated or rounded scales; rostrum as long as the head and thorax, linear; scales like robust hairs; transversely indented over the insertion of the antennæ; a longitudinal impressed line; tip naked rufous; thorax with the hair-like scales converging backwards to the dorsal line. Elytra with indented striæ, punctures are not visible, with densely imbricated, rounded scales; middle of the interstitial lines with a series of prostrate scale-like hairs; thighs unarmed, emarginate.

Inhabits Missouri. Length three-twentieths of an inch. Can this be *C. penicellus*, Herbst?

15. **Conotrachelus confinis** Fahræus, Sch. Curc. iv, 430.

Ovalis, niger, pube grisea parce adspersus; rostro basi superne, antennis, femoribus posterioribus medio, tibiis, tarsisque rufo-testaceis; thorace ampliato, rugoso-punctato, linea utrinque flexuosa densius griseo-tomentosa; elytris pone medium late griseo-fasciatis; interstitiis alternis modice elevato-costatis, costa intima pone medium interrupta; femoribus æqualiter bidentatis.

Pennsylvania. The long description adds little to the diagnosis, which indicates a species allied to and perhaps identical with *C. elegans*, p. 228.

16. **Rhytidisomus orobinus** Schiödte, Berl. Ent. Zeitschr. 1859, 141.

Nigro-piceus, unicolor, antennis pedibusque rufis, elytris callo humerali protuberante, interstitiis sulcorum dorsalium angustis, acute elevatis, imbricato-dentatis, lateralium latis, convexiusculis, sublævibus, singulis serie punctorum simplici impressis. Long. ¾ lin."

Greenland. I infer from the remarks appended to the diagnosis, that this species differs from the European *R. globulus* by the smaller size, as well as by the characters above given.

17. **Rhynchænus umbellæ** Fabr., Syst. El. ii, 450.

Nigricans, elytris striatis, scutello albo.

Habitat in Carolina, Mus. Dom. Bosc. Statura *R. pericarpii* at major et alius. Caput nigrum. Thorax lævis, nigricans, immaculatus. Elytra

Digitized by Google

parum pallidiora, striata ; striis ante apicem coeuntibus. Scutellum album, at sutura elytrorum omnino concolor. Corpus cinereum pedibus nigris.

The description is worthless, as is indicated by the expression thorax lævis. The specimen upon which it was based, should probably be referred to *Rhinoncus pericarpius*, p. 284.

18. **Baridius californicus** Motsch., Bull. Mosc. 1845, ii, 372.

Oblongus, subdepressus, niger, punctatus, parce pilosus ; rostro longitudine thoracis, tenue, subarcuato ; thorace quadrato, antice angustato ; elytris postice subattenuatis, striatis, striis in fundo punctatis ; interstitiis subtiliter punctato-striatis. Long. 1¾ lin. ; lat. 1 lin.

Il est plus petit que le *B. picinus*, dont il se distingue facilement par les élytres faiblement pubescentes. De Californie.

19. **Baridius californicus** Boh., Eugenies Resa. Ins. 137.

Ovatus, modice convexus, nigro-piceus, nitidus glaber ; antennis pedibusque rufo-ferrugineis ; rostro ferrugeneo modice arcuato, prothorace vix longiore, hoc brevi, sat crebre punctulato, pone apicem valde rotundato-ampliato ; elytris castaneis, mediocriter punctato-striatis, punctis striarum minus crebris, interstitiis planis, lævibus. Long, 1¾ ; lat. 1¼. mill.

California, San Francisco. The detailed description gives no farther characters for the recognition of this species.

20. **Centrinus pistor** Gyll., Sch., Curc. iii, 170. Ins. Nov. 295, (*Balaninus*).

Femoribus muticis, niger, griseo-tomentosus, thorace supra scutellum producto, acuto, elytris triangularibus, striatis. Habitat in America septentrionali, (Kentucky).

B. cerasorum paullo major. Rostrum dimidii corporis longitudine, tenue, incurvum, læve, denudatum, atrum, antennæ rostri medio insertæ, piceo-nigræ, funiculi articulis 1–2 elongatis, reliquis subæqualibus, cylindricis. Thorax latitudine postica parum brevior, lateribus a basi ultra medium sensim, tunc apicem versus subito angustatis, basi subtruncatus, supra scutellum triangulariter productus, acutus, griseo aut fulvo, dense tomentosus. Scutellum rotundum tomentosum. Coleoptera triangularia, abdomine brevioria, striata, fulvo aut griseo-tomentosa. Pectus et abdomen albo-squamosa. Pedes nigri, grisco-tomentosi, femoribus parum clavatis, muticis.

The reference to *Centrinus* seems to me doubtful, in view of the expression *Coleoptera abdomine breviora*. I have seen nothing that could be properly referred to this description.

21. **Centrinus ? dilectus** Harris, Trans. Hartford Soc. Nat. History 80, pl. 1, fig. 4.

Punctured, and with brassy scales ; scutel whitish, third joint of the antennæ twice as long as the fourth. Length, exclusive of the rostrum twenty-hundreths of an inch.

Halsey's collection, No. 165. Body piceous black, densely punctured, and with elongated brassy-yellow scales. Head retracted to the eyes within the thorax, indented at the base of the rostrum. Rostrum as long as

Digitized by Google

the head and thorax, slender, almost filiform, arcuated, slightly dilated over the origin of the antennæ, piceous, minutely and remotely punctured. Antennæ inserted behind the middle of the rostrum, piceous, club rufous; third joint (second of the funiculus), two-thirds the length of the preceding, and twice the length of the following joint, Thorax in the middle, longitudinally elevated, or almost carinated, covered with linear-lanceolate scales, which converge from the sides towards the central carina. Elytra with acute, remotely punctured striæ, and flat interstitial lines, each one of which is covered with large superficial confluent punctures, and three or four series of linear-lanceolate scales; an oblique elevation or callus before the tip of each elytron. Body beneath more densely covered with whiter, shorter oval scales. Breast, before the anterior legs, widely indented, not canaliculate, unarmed.

22. **Balaninus porrectus** Boh., Sch. Curc. vii, 2d, 292.

Ovatus, niger, squamositate griseo-olivacea dense tectus; rostro tenui, longitudine elytrorum, subrecto; thorace angustiore. confertim punctulato, intra apicem constricto; elytris tenuiter punctato-striatis, interstitiis planis subtiliter coriaceis; femoribus anticis obsolete dentatis, posterioribus muticis.

Missouri, Americæ borealis, Dom. Say, Mus. Sch.

Balanino cerasorum vix latior, sed nonnihil longior. Caput parvum, subglobosum, subtilissime punctulatum, nigrum nitidum, glabrum; oculi subrotundati, depressi, nigri; rostrum longitudine elytrorum, tenue, cylindricum, subrectum, piceo-nigrum vix punctatum basi griseo-olivaceo-squamosum. Antennæ thoracis medium attingentes, piceæ, parce pilosæ; clava parva, ovata, subobtusa. Thorax latitudine postica fere longior, apice truncatus, anterius nonnihil angustior, intra apicem constrictus, lateribus paulo rotundato-ampliatus, basi bisinuatis, supra convexus, subtiliter crebre punctulatus, niger, squamis depressis griseo-olivaceis dense vestitus. Scutellum parvum, subtriangulare, nigrum, dense griseo-squamulosum. Elytra antice subtruncata, thoracis basi nonnibil latiora, humeris vix elevatis, obtuse rotundatis; lateribus non ampliata, apicem versus angustata, apice conjunctim obtuse rotundata, thorace duplo longiora, supra parum convexa, tenuiter punctato-striata, interstitiis planis, subtilissime coriaceis; nigra, squamulis depressis, griseo-olivaceis, dense vestita. Corpus subtus subtiliter crebre punctulatum, nigrum, squamulis tenuioribus, cinereo-albidis undique æqualiter obsitum. Pedes validiusculi, rufo-picei, cinero-squamulosi; femoribus clavatis, anticis obsolete dentatis, posterioribus muticis, tibiis tere-tibus, rectis.

The reference to this genus seems to me doubtful, especially as the species is immediately followed by *B. constrictus*, which has no resemblance to *Balaninus*, but is an *Erirhinine* (p. 168). It is quite possible, that this insect, on renewed study of the type in Stockholm, may prove the same as my *Desmoris scapalis*, which is congeneric with *D. constrictus*.

23. **Brenthus peregrinus** Herbst, vii, 190, pl. 108, f. 1.

This is evidently a species from Tropical America, either with an incor-

Digitized by Google

rect locality, or accidentally introduced. It is therefore, unnecessary to reprint the description. In the Munich Catalogue, 2713, it is cited as a synonym of *B. anchorago.* ♀

24. **Cossonus californicus** Motsch., Bull. Mosc. 1845, i, p, 99, No. 228.

"Niger, glaber, subdepressus; rostro breviori, crassiori, apice modice dilatato, basi obsolete foveolato; antennarum articolo breviori (sic); thorace oblongo, profunde punctato, medio distincte longitudinaliter biimpresso, elytris profunde punctato-striatis. Long. 2 lin.; larg. ⅔ lin."

He says that it resembles *C. piniphilus*, but is much smaller and easily recognized by the stouter and shorter antennæ, and by the two longitudinal impressions at the middle of the thorax.

25. **Pityophthorus cribripennis** Eichhoff, Berl. Ent. Zeitschr. 1868, 274.

Elongatus, cylindricus, thorace oblongo, lateribus subrectis, postice minus profunde punctato, linea media lævi; elytris ad suturam indigeste (extra striato–) punctatis, declivitate postica ad suturam utrinque sulcata, sutura subelevata, margineque laterali subtilissime granulatis, angulo apicali acutiusculo. Long. 1 lin. Patria ; America septentr.

26. **Pityophthorus bisulcatus** Eichhoff, ibid. 1868, 274.

Elongatus, cylindricus, thorace oblongo-ovali lateribus subrotundatis, postice vage subtiliter punctato, linea media lævi; elytris subtilius striato-punctatis, punctis, dilatatis, interstitiis inde angustioribus subrugulosisque ; declivitate postica ad suturam utrinque sulcata, sutura valde elevata margineque subcalloso subtiliter granulatis, angulo apicali acutiusculo. Long. ¾ lin. Patria : America borealis.

27. **Pityophthorus pulchellus** Eichhoff, ibid. 1868, 275.

Oblongo-elongatus, thorace breviter-ovali, postice fortiter ruguloso-punctato, linea media lævi ; elytris striato-punctatis interstitiis subrugulosis ; decliviate postice ad suturam utrinque sulcata, sutura subelevata margineque laterali subtiliter granulatis, angulo apicali acutiusculo. Long. ¾ lin. Patria : America septentr.

28. **Tomicus oregonis** Eichhoff, Berl. Ent. Zeitschr. 1868, 274.

Oblongus cylindricus nitidus, thorace subquadrato, postice profundius punctato ; elytris subtiliter striato-punctatis, interstitiis internis basi lævibus ; elytris apice oblique truncatis, truncatura excavata circulari, spatio nitido punctato, margine apicali prolatato, laterali utrinque 4-dentato, dente tertio coarctato majore, secundo valido acuto. Long, 2 lin : Amer. bor. (Oregon).

29. **Tomicus perturbatus** Eichh. l. e. 274.

Oblongus, cylindricus, subnitidus, thorace breviter ovato, postice fortiter punctato ; elytris subcrenato-striatis, stria suturali profundiore pone medium fortiter ruguloso-punctata, interstitiis convexiusculis lævibus, apice oblique truncatis truncatura excavata spatio punctato nitido, margine laterali utrinque 4-dentato, dente tertio majore, a primo minimo remoto ; margine apicali longe elevato. Long. 2½ lin. Amer. bor.

Digitized by Google

30. **Phlœosinus Haagi** Chapuis, Mem. Soc. Roy. Sc. Liége, 1869, 94. *Dendroctonus Haagi* Eichhoff, Berl. Ent. Zeitschr. 1868, 148.

Breviter ovatus, subopacus, piceus, nonnunquam antennis tarsis et elytris brunneis, pube brevi flava vestitus; capite crebre ruguloso-punctato, inter oculos spatio nitido, apice carinato; prothorace latitudine basis breviori, a basi ad apicem angustato, sat dense fortiter punctato, linea media angusta elevata, a basi ultra medium producta; elytris anguste striato-punctatis, striis vix punctatis, interstitiis rudibus, sat dense minute granulatis, in declivitate seriatim tuberculatis, 1mo. et 3io subconvexioribus. Long. 2½ mill.: Am. bor.

31. **Phlœosinus graniger** Chapuis, ibid. 95.

Breviter ovatus, subopacus piceus, elytris et pedibus brunneis, antennis flavis, pube brevi flava dense vestitus; capite crebre punctulato, apice carinulato; prothorace latitudine basali breviori, a basi ad apicem angustato, dense et fortiter punctato, linea media a basi ultra medium elevata, sublævi; elytris striato-punctatis, interstitiis dense granulato-rugulosis, in declivitate seriatim tuberculatis, 1mo. et 3io convexioribus, tuberculis majoribus ornatis. Long. 2 mill. Texas.

Digitized by Google

APPENDIX III.

Corrections to the Munich Catalogue,

2187. **Liophlœus inquinatus** Mann. is Lophalophus.

2219. **Tanymecus leucophæus** Gyll. is *T. lacaena* ♂ p. 84.

2271. **Tyloderes gemmatus** Lec. is Phymatinus.

2282. **Peritelus sellatus** Boh. is Paraptochus.

2286. **Ptochus adspersus** Boh. is Neoptochus.
Ptochus globiventris Lec. is Peritelopsis.

2287. **Ptochus saccatus** Lec. is Mylacus.

2288. **Trachyphlœus melanothrix** Kirby is Geoderces.

2289. **Trachyphlœus squalens** Lec. is Thinoxenus.

2315. **Ophryastes tessellatus** (Say) is Aramigus.

2359. **Listroderes.** Some of these are *Listronotus*, and others are *Macrops*.

2424. **Curculio tæniatus** Lec. is Plinthodes.
Curculio torpidus Lec. is Nocheles.

2435. **Grypidius vittatus** Couper, is *Sitones tibialis*.

2436. **Erirhinus ephippiatus** Say is Alyca.

2482. **Attelabus scutellaris** Say is Piazorhinus.

2496. **Balaninus constrictus** Say is Desmoris.

2502. **Anthonomus tessellatus** Walsh is Dorytomus.

2541. **Conotrachelus cristatus** Fahraeus, iv, 438; a West Indian species not known to occur in the United States.

2610. **Ceutorhynchus umbellæ** Fabr. is *pericarpius*.

5621. **Baris.** The species in my synopsis, Pr. Acad. Nat. Sc. Phila., 1868, 361, are not cited.

2650. **Sphenophorus præpotens** Say, is Lixus, as is indicated by the pubescence of the surface, (v, p. 431).

2672 & 3. **Haagi and graniger** Eich., appear under two genera, *Dendroctonus* and *Phlœosinus*.

2673. **Hylesinus aculeatus** Say, is incorrectly referred to *Dendrosinus* and *D. globosus* is placed as a synonym.

2681. **Aphanarthrum pumilum** is Dolurgus.

2695. **Scolytus muticus** Say, dele the reference to Chapuis.

2749. **Aræocerus fasciculatus. Anthribus moestus** Lec., is not a synonym of this species, but belongs to Piezocorynus.

Digitized by Google

APPENDIX IV.

The following bibliography of the memoirs relating to Economic Entomology of the Rhynchophora of the United States, has been prepared at my request by Mr. B. Pickman Mann, of Cambridge, Mass.

It will be an invaluable addition to this volume, for all who desire to study the habits of these insects: a prerequisite to any rational enquiry into the means to be adopted for the suppression of the noxious species. Such a study has been heretofore almost impracticable in this country, in consequence of the large number of undescribed species, and the scattering of the descriptions of those which have been named in a multitude of volumes, many of which can only be obtained with much labor and great cost. For the proper use of the tables, certain explanations are necessary.

I. The subjects mentioned in the articles cited are indicated as follows:

b. benefits.	*d.* description.	*f.* food.
h. habits.	*i.* injuries.	*l.* localities.
r. remedies.	*s.* seasons.	*t.* transformations.

II. The * after a reference indicates that the article is illustrated with a figure of the insect in question.

Name.	Work.	Vol.	Page.	Subject.
abietis. Hylobius	11	5	171	f i
ampelopsidis. Madarus	3	2	105	d f i
analis. Attelabus	14		65-66*	d h s
bicolor. Rhynchites	14		66	d f i s
bipustulatus. Attelabus	14		66*	d h
" "	22	4	143-145	d f h s t
calligraphus. Tomicus	16	17	721-722	d f h i s
carbonarius. Hylastes	16	17	730	d s
caryæ. Scolytus	17	5	103-108*	d f h i l r s t
cerasi. Rhynchænus	11	2	282	d f h i l s t
" "	11	5	171	—"Curculio nenuphar"
" "	11	7	81-82	d f h i r s t
" "	14		78	—"Conotrachelus nenuphar"
coffeæ. Aræocerus	22	5	156	i l
cratægi. Conotrachelus	10	2	81	f
" "	10	2	120	f l
" "	17	8	35-39*	d f h i l r s t
dentatus. Hylurgus	14		87	d f h s
" "	16	17	750	d f h i
destructor. Hylesinus	11	5	169-171 }	f h i r
" Scolytus	11	5	169-171 }	
exesus. Tomicus	14		87-88	d f h i l s
fragariæ. Analcis	17	8	42-44*	d f h i l r s t
granarius. Curculio	11	4	228	r
" "	11	7	62-63	i r
" Sitophilus	3	1	179	b f i
" "	14		83	d f h i r
hilaris. Curculio	14		70*	d f s
Hylurgus spp.	11	5	171	d f i
imbricatus. Epicærus	10	2	81	f i l
" "	17	8	58*	d f i l
inæqualis. Cœliodes	8	2	52	f s
" "	17	1	128-129*	f i l s t
" "	21	1	13-21*	d f h i l r s
liminaris. Tomicus	14		88	d f s
" "	16	16	356-357	d f i s
mali. Tomicus	16	16	326-327	d f i l
materiarius. Tomicus	16	17	726-728	d f h i
minuta. Eupsalis	17	6	113-117*	l
monographus. Tomicus	3	2	207	d f h i t
nasicus. Balaninus	14		74-75	d f h s

Digitized by Google

Name.	Work.	Vol.	Page.	Subject.
nenuphar. Conotrachelus	3	1	3-4	r
" "	3	1	11-13	f h i r s
" "	3	1	32	f i
" "	3	1	33	r
" "	3	1	34-36	i l r
" "	3	1	56	r
" "	3	1	80	h s
" "	3	1	92-93	f r
" "	3	1	156	h
" "	3	1	161	r
" "	3	1	183	r
" "	3	1	202-218	r
" "	3	1	217-221	h
" "	3	1	220-241	r
" "	3	1	226	r
" "	3	1	239	h i r s
" "	3	1	244	h
" "	3	1	252	f
" "	3	2	53	r
" "	3	2	56	r
" "	3	2	119-121	h
" "	3	2	130-137*	d f h i r s t
" "	3	2	165	r
" "	3	2	169-170	r
" "	3	2	225-227	h r s
" "	3	2	268-271	r
" "	3	2	274	r
" "	3	2	276	f
" "	3	2	336	f i
" "	3	2	338	r
" "	10	1	6	general
" "	10	2	29-30	general
" "	10	2	31	f r s
" "	10	2	71	r
" "	10	1	74	(worthless) r
" "	10	2	75-81	d f h i r s
" "	10	2	97	r
" "	10	2	114-115	h
" "	11	2	69-70	f h i r t
" "	11	5	405-406	f h i r s t
" "	11	7	291	f h r s
" "	11	8	17-18	f h i l r s
" "	11	8	382	r
" "	11	9	153	f r
" "	11	9	356	f h r s
" "	11	9	393-394	f h i r s
" "	11	9	405	f i
" "	11	9	413	f h r
" "	11	10	405	h
" "	11	10	411	i
" "	11	11	1	h (worthless)
" "	11	16	349	f h r t
" "	11	16	389	i r
" "	14		75-81*	d f h i r s t
" "	16	16	347	f i
" "	16	16	349-352	f h i r s t
" "	16	16	359	f i
" "	16	16	360	f
" "	16	16	365	d f h i
" "	16	16	387	f
" "	16	16	461	f i
" "	17	1	50-62*	f h r s
" "	17	3	11-29*	f h l r s
" "	21	1	64-72	d f h l r s
" "	22	2	137-139*	f h r
" "	22	3	12, 26*	r
" Curculio	11	5	171	f i
noveboracensis. Ithycerus	3	1	221-222*	d f h i l r
" "	3	2	176-177	f h i s
" "	3	2	246	f i
" "	10	2	81	f i l
" "	10	2	107	f i l r
" "	16	16	331	d f h i s
" "	17	3	57-58*	d f h i l

Digitized by Google

NAME.	WORK.	VOL.	PAGE.	SUBJECT.
oryzæ. Sitophilus	14		83-84*	d f h i l r s
pales. Hylobius	14		70-72*	d f h i l s
picivorus. Hylobius	16	17	731	d f h
pini. Curculio	11	5	171	f h i l
" Tomicus	14		88*	d f i l s
" "	16	17	722-723	d f h i
" "	16	17	751	f h i
pinifex. Hylastes	16	17	729-730	d h
posticatus. Conotrachelus	10	2	81	f
prunicida. Anthonomus	3	1	11	f h r s
" "	3	1	93	f
" "	10	2	79-80	d f h l r s
" "	17	3	39-42*	d f h i l r s
" "	21	1	72-78	d f h i l s
pubescens. Attelabus	16	16	475-476	d f h i s
pulchellus. Sphenophorus	17	3	60*	d f h s
puncticollis. Conotrachelus	10	2	81	f i l
pusillus. Tomicus	16	17	724-726	d f h i
pyri. Scolytus	11	5	1-2*	d f h i r s t
" "	11	5	6	f i
" "	11	5	17-18	f i r
" "	11	5	22	f i
" "	11	5	25-26	f i
" "	11	5	38	f
" "	11	5	38-39	f i
" "	11	5	41	f i r
" "	11	5	50-51	f i
" "	11	5	113	f i
" "	11	5	171	f i r
" "	11	8	401	d f h i r s
" "	11	9	6	f i
" "	11	9	21-22	f i
" "	11	9	85	f i
" "	11	9	137	f i r
" "	11	9	361	f i r
" "	16	16	327-328	f h i
" "	16	16	330	f h i
" "	16	16	353-354	d f i s
" "	16	16	360	f i s
" Tomicus	14		88-91	d f h i l r s t
quadrigibbus. Anthonomus	3	1	36	f i
" "	3	2	227	d
" "	3	2	243*	d
" "	3	2	306	f h l
" "	10	2	80-81	d f h i l r
" "	17	3	29-35*	d f h i l r s t
rectus. Balaninus	16	16	476-477	d f h i
robustus. Balaninus	10	2	81	f i l
sayi. Apion	14		67*	d f i
Scolytus spp.	10	2	57-58	d f
" "	11	5	66	f i
" "	11	5	302-303	i r
septemtrionis. Brenthus	14		67-69*	d f h i l s t
sesostris. Baridius	3	2	104-106*	d f i
strobi. Pissodes	3	2	26*	f i l r s
" "	14		71-73*	d f h i r s
" "	16	17	732-736*	d f h i l r s t
" Rhynchænus	11	5	171	f i
" Rhynchœnus	10	1	20	d f i l r s
stupidus. Hylobius	3	2	61	f
suturalis. Anthonomus	3	1	79*	f i r
" "	12		487-488	d f h s
sycophanta. Anthonomus	3	2	46	d f h i s t
terebrans. Hylurgus	14		84-86*	d f h i s t
" "	16	17	728-729	d f h i s
" Scolytus	11	5	171	d
trinotatus. Baridius	3	1	22-23*	d f h i l s t
" "	14		81-82*	d f h i l s t
" "	17	1	93-95*	d f h i l r s t
typographus. Bostrichus	11	5	170	i l
vitis. Madarus	17	1	181-182*	d f h i s t
xylographus. Tomicus	16	17	716-721	d f h i l s t
zeæ. Sphenophorus	10	2	117-118	d! f h i l
" "	17	3	59*	d f h i l

Digitized by Google

Works cited in the foregoing List.

8. American Entomologist, Vol. I–II (all).
10. Practical Entomologist, Vol. I–II (all).
11. New England Farmer, Vol. I–XVII.
12. Packard's Guide to the Study of Insects (1869).
14. Harris' Insects Injurious to Vegetation (1862).
15. Fitch's Reports on Insects of New York. Nos. 1, 2, 6–9 (*contain nothing on Rhynchophora*).
16. Transactions of the New York State Agricultural Society, Vol. XVI–XVII (containing Fitch's Reports, Nos. 4 and 5).
17. Riley's Reports on Insects of Missouri. Nos. 1–8 (all to date).
21. Walsh's Report on Insects of Illinois. No. 1 (all).
22. Canadian Entomologist, Vol. I–V.

It will be seen that I have not examined the New England Farmer, Vol. XVIII *et seqq.*; Fitch's Reports, Nos. 3, [4, 5,] 10, *et seqq.*; Trans. N. Y. State Agric. Soc., Vol. I–XV, XVIII, *et seqq.*

The examination of the New England Farmer, from the beginning of Vol. LIII; of the Canadian Entomologist, from the beginning of Vol. VI, and in general of all entomological literature pertaining to North America from the beginning of the year 1874, is taken up in detail in PSYCHE, the organ of the Cambridge Entomological Club.*

References to Titles in the BIBLIOGRAPHICAL RECORD OF PYSCHE, *Vol. I.*

Aræocerus coffeæ. No. 147 *b*.
Calandra oryzæ. No. 290 *f*.
Conotrachelus nenuphar. Nos. 37, 146 *j*, 149 *n*, 161 *o*, 237 *o*, 310, 381 *d*, 535 *b*, 539.
Cionus scrophulariæ. No. 414.
Curculionidæ. No. 202.
Eupsalis minuta. No. 39.
Hylobius pales. No 168
Lixus rubellus. No. 695
Magdalinus 5 pp. No. 646.
Pissodes strobi. No. 168.
Rhynchænus nenuphar. No, 38.
Rhynchophora, Nos. 142 *i*, 265, 292, 321, 570, 607.

Additional References.

(Mostly quoted without verification).

Analcis fragariæ. Maine Farmer, July 25, 1867. [17 : 3 : 42].
Anthonomus prunicida. Prairie Farmer, June 13, 1863. [17 : 3 : 39]. March 19, 1864. [21 : 1 : 76].

*Published in monthly Nos. by the Cambridge Entomological Club, Cambridge, Mass.

Digitized by Google

Baridius 5 pp. Proc. Acad. Nat. Sci. Philad., Dec. 1868 [3 : 2 : 105].

" **Sesostris.** Missouri Agricultural Report for 1868, p. 131–132 (1869). Gall (*Vitis vulnus*) described without name. [3 : 2 : 104].

Baridius trinotatus. New England Farmer, ser. 2, Vol. II (1850), p. 204.

Calandra granaria. New Engl. Farmer, Vol. XIX. (1841). p. 300.

Cœliodes inæqualis. Transactions of the Illinois State Agricultural Society, Vol. I. (1853) p. 340, New York Tribune, Oct. 29, 1867. [21 : 1 : 13].

Conotrachelus nenuphar. New Engl. Farmer, Vol. XIX (1841), p. 405*; ibid., XXII (1843), p. 13; ibid., ser. 2, II (1850), p. 252; Boston Cultivator, Vol. XIII (1851), No. 24; Downing's Horticulturist, Vol. VI, p. 341; Trans. Illin. State Agric. Soc., Vol. II (1855), p. 48. [21 : 1 : 64]; ibid., 1867, 113–114 [17 : 1 : 51] ; Prairie Farmer, July 27, 1867 [17 : 1 : 51] ; ibid., July 16, July 23, Aug. 27, 1870 [17 : 3 : 30] ; Tilton's Journal of Horticulture, June 1868 [3 : 2 : 276] ; Report of the Alton (Ills.) Horticultural Society for July 2, 1868 [3 : 1 : 3] ; Journal of Agriculture, Oct. 13, Nov. 10, Nov. 17, 1870 [17 : 3 : 30].

The **Curculio**, by James Tilton, M.D., Georgick papers for 1809, Mass. Soc. Promot. Agric., p. 15–19.

The **Curculio**, by James Allen, Am. Quart. Journ. Agric., (1846), Vol. IV., p. 127–128.

Address on Curculio, by Asa Fitch, M.D., 1860. [21 : 1 : 65].

Essay on the Curculio, by E. S. Hull, M.D. [3 : 2 : 276].

A Treatise on the Insect Enemies of Fruit and Fruit Trees [etc.]. By Isaac P. Trimble, M.D. New York, Wood, 1865, 4 to pg. 139. The Curculio and Apple Moth. [10 : 1 : 6].

Epicærus imbricatus. Prairie Farmer, July 18, 1863. [10 : 1 : 31].

Ithycerus noveboracensis. Trans. New York State Agric. Soc., Vol. XIII (1854), p. 188–189.

Madarus vitis. Trans, Illin. State Hortic. Soc. for 1867. [17 : 1 : 131].

Rhynchænus cerasi. Massachusetts Agricultural Repository and Jour. Vol V, (1819), p. 307–313, pl. 1.

Rhynchænus strobi. ibid., Vol. IV. (1817), p. 205–211, pl. 2.

Scolytus caryæ. Prairie Farmer, Feb. 2, 1867 [10 : 2 : 58] ; Aug. 10, 1872 [17 : 5 : 105].

Scolytus pyri and strobi. Mass. Agric. Rep. and Journ., Vol. IV, (1817), p. 205–211, pl. 2.

Tomicus eruditus (Westwood), Scudder, Proc. Bost. Soc. Nat. Hist., 10, p. 13–14 (1865). Mentions that a volume in the Boston Athenæum had been attacked in a manner similar to that described by Professor Westwood. No specimens found.

Tomicus pyri. Massachusetts Ploughman, Vol. II No. 38, June 17. 1843 ; New Engl. Farmer, Vol. XXII (1843), p. 21 ; Downing's Horticulturist, Vol. II, p. 365–367.

Digitized by Google

INDEX.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD AT PHILADELPHIA, FOR PROMOTING USEFUL KNOWLEDGE.

VOL. XVI. JANUARY TO JUNE, 1876. No. 97.

N. B.—No. 96 will appear as a separate Volume.

TABLE OF CONTENTS.

Digitized by Google

Digitized by Google

vol. 16, nos 97-99

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY.

Vol. XVI. 1876. No. 97.

A Discourse, illustrative of the life and character of Horace Binney, *delivered before the Bar of Philadelphia, the Law Association, and the American Philosophical Society, in the Musical Fund Hall, on the evening of Jan.* 5, 1876.

By Judge William Strong.

Forty years ago, in this Hall, on an occasion much like the present, Mr. Binney commenced his eulogy of Chief Justice Marshall with the following remark, "The Providence of God is shown most beneficently to the world, in raising up, from time to time, and in crowning with length of days, men of pre-eminent goodness and wisdom." The thought thus expressed is worthy of recall to-day. At intervals, all along the line of human history, and especially in enlightened communities, men have appeared, who, by their native endowments, their thorough culture, their ceaseless energy, and their moral worth, have raised themselves to a plane above that of their fellows; men who have been in advance of all their cotemporaries, and to whom the rank of leaders has been universally conceded. Such

Digitized by Google

leaders have arisen in every department of social life, in the learned professions, among the devotees to fine arts, in the regions of invention, in the explorations of natural science, in mechanical pursuits, in those of commerce, and even in the department of agriculture. Occasionally some noted one has lifted his standard of attainment higher than that of any of his predecessors, and has gone forward beyond their utmost reach. Such men are among the best gifts to the world, of a beneficent God. It is through their agency society makes progress. They lead the onward way. Their lives lend attractive force to that which is truly valuable. They present models for imitation, and their achievements stimulate to a generous rivalry. Their standard, "full high advanced," is ever visible, and it calls, with a noiseless but persuasive voice, to those who are behind to move onward. No one can overestimate the value of such a life to young men in the legal profession, if it be kept ever in view. If they have not mistaken their calling, it must win their admiration, and stir the noblest impulses of their hearts. It is a perpetual reproof of contentment with any attainments less than the highest possible, a rebuke of character and conduct unbecoming the best aims, and it gives courage for the grandest efforts.

Happily the lessons of such a life are beyond the reach of death. They are the rightful property of more than one generation. They ought never to fade into oblivion. To preserve them with gratitude for

Digitized by Google

the past and with hope for the future, is a duty which the living owe to themselves and to those who shall come after them. And this duty is best performed as a skillful painter preserves in memory the subject of his portrayal. A portrait is not a life, it is true, but it recalls a life. So a delineation of character and achievement, if it be accurate, prolongs the influences the character is fitted to exert. It is therefore in obedience to your desire to perpetuate, so far as may be, the instruction and example of a life more than commonly eminent and useful, that I am to speak to you of Horace Binney.

He was born in Philadelphia on the 4th day of January, A. D., 1780, in a house belonging to Thomas Williams, in what was then known as the Northern Liberties, and in the neighborhood of Front and Coates streets. He was of Scotch and English descent. The earliest paternal ancestor of whom he had knowledge was John Binney, who, in 1680, resided with his wife Mercy, in the town of Hull, Boston Bay, in England, and from whom he was the fifth by descent in right line. The family came to this country about that time and settled in Hull, Massachusetts. The grandfather of Horace was Barnabas Binney, a shipmaster and merchant of Boston, and his father (born in 1751,) named also Barnabas Binney, was a surgeon in the revolutionary army, attached to the Massachusetts line, whence he was transferred to the Pennsylvania line. After his transfer he settled permanently in

Digitized by Google

Philadelphia, and, in 1777, he married Mary, the eldest daughter of Henry Woodrow, a man of Scotch ancestry, a whig in politics, of great purity of character and uprightness of life. Dr. Barnabas Binney was a man of liberal education, and a graduate in 1774 of Brown University, where he attained the highest distinction in his class. Thence he came to this city, and attended medical lectures at the University, in due time receiving from it a degree. He was an accomplished "belles-lettres" scholar, and acutely sensitive to the beauties of English literature. He wrote with ease and elegance, and he cherished both the taste and the talent for poetical composition. Withal his intellectual powers were fine, and he had a strength of principle, a decision and energy of action, and a sensibility and tenderness of feeling that commanded the respect of all who knew him, and greatly endeared him to the circle of his domestic friends.

Dr. Binney's wife, the mother of Horace, was also a superior person. In many points her intellectual traits and those of her husband were much alike. She had besides a keen perception and taste for wit and humor, and a remarkable faculty for catching and imitating personal peculiarities of manner, voice, and almost of look. In the character of her mind there was a large element of the dramatic. Her manner was impressive, and she had that rare union of dignity and ease which woman alone possesses, without the appearance of effort, and which she only can teach.

Digitized by Google

At the age of six years, Horace was sent to his first school, which, for a short time, was the Friends' Alms House School, in Walnut street between Third and Fourth. Very soon afterwards, he entered the Grammar school of the University of Pennsylvania, where he remained until his father's death, which occurred in 1787. Thus early, when only seven years of age, he was left an orphan, in charge of a widowed mother. In 1788 he was placed in a school at Bordentown, New Jersey, where he continued three years, and acquired the reputation of being the best scholar in the school; beginning thus early to give promise of what he afterwards became. His attainments in knowledge of the Greek language especially, must have been remarkable for a youth of only ten or eleven years. And not only was his scholarship of an high order, but his conduct was such as to commend him to the confidence of his teachers, for he was promoted to be "guider" of boys older than himself.

Leaving Bordentown in 1791, he returned to his mother's residence, in Philadelphia, then on Market between Fifth and Sixth streets, immediately opposite the residence of General Washington, and adjoining that of Alexander Hamilton. There he frequently saw the first President of the United States, as also Mrs. Washington, who was his mother's friend, of both of whom he had perfect recollection throughout his life. There he was also a witness of the ceremonies of the day; imposing ceremonies, which were remnants of

Digitized by Google

colonial usages derived from the mother country, but which long since went into desuetude. What effect such associations and opportunities had upon his youthful mind, never wanting in a pure and generous ambition, may readily be conjectured.

In 1791 his mother entered in a second marriage with Dr. Marshall Spring, of Watertown, Massachusetts, (now a suburb of Boston,) and in 1792 he went to reside with his stepfather, for whom he ever after felt warm affection and profound respect. Soon thereafter he was sent to a boarding-school near Medford, six miles from Boston. Even then, though only twelve years old, he was prepared for admission to college, but he was considered too young to enter, and he was sent to school rather to grow older, than to increase his intellectual preparation for college life. He did not remain long at Medford, because of a conviction he had that his master was incompetent to instruct him in the Greek language. An interesting incident is related of his short school life there, illustrative of his confidence in the accuracy of his knowledge, and of his resolute adherence to that which he believed correct, even to the extent of what may be considered rudeness. On the day after his arrival at school, he was called up to recite to his new master a Greek lesson in the New Testament. He began with confidence, but he had not proceeded far when he was stopped, and told he was wrong, and what the master deemed the proper translation was given. Instead of

Digitized by Google

accepting the correction silently, he insisted that he was right and that the master was wrong. This brought immediately the rebuke, "Is this your Philadelphia politeness?" to which he replied, "It is my Philadelphia Greek, sir."

After leaving the school at Medford, he was placed in the care of a clergyman at West Cambridge, in whose family he remained until July, 1793, when he entered the Freshmen class at Harvard University, the president of which, at that time, was the Rev. Joseph Willard, D. D. and LL. D. In the autumn after his admission he unfortunately lost his mother by her death, and thus became doubly an orphan. How he acquitted himself in college is shown by the fact that on his graduation in 1797, he divided the first honor of his class with a single classmate.

It was at Bordentown and at Harvard that Mr. Binney laid the foundation on which he subsequently built his character and his fame. Protected by Divine Providence, as he was wont to acknowledge, against the perils that even then beset the paths of young men in a college course; having an ardent desire for distinction in his class, a desire which forbade any deviation from moral rectitude, and sternly resisted every temptation to indolence, or vicious indulgence; he secured for himself all the advantages of mental and moral culture, which the most advanced collegiate education in this country could then give. Through his entire college life his intercourse with the officers of

Digitized by Google

the institution was one of one uninterrupted respect on his part, and of affectionate confidence on theirs. Knowledge, of course, he acquired, but that was the least of his acquisitions. He acquired the art and the habit of study, with an unfading love for it, and this acquisition was permanent. It continued to be his delight and a great element of his power until the close of his life. Never for a moment did he make the mistake, into which so many fall, of considering the *primary* object of a liberal education to be securing a knowledge of facts, or of arts, or of sciences which might be useful in after life. This knowledge he knew would decay. He sought and he obtained the "art of all arts the best,"—that of setting the mind intently upon a subject of thought, and holding it there until the subject is thoroughly understood.

This power or art of study which he acquired during his college life, he ever regarded as his most important gain, and many years afterward he spoke of it as such. Much of what he acquired he said he had lost. His knowledge of the Latin and Greek classics, as well as of the higher mathematics, had fallen away from disuse, though he had preserved enough to assist his children in their education, "but," he added, "the ununfading art which I acquired at college was that of study, and if the acquisitions of knowledge I then made by it are faded, or fallen from the surface, * * certainly the art or faculty of study has never left me." His appetite for study while he was in college was so

Digitized by Google

great, that on one occasion, instead of going to his stepfather's, where he was always happy, he remained in his chambers in one of the college buildings during an entire autumnal vacation, and studied every day of it fourteen hours. Habits and tastes like these were his constant shield, as well as his instruments of power; and long after his graduation he was able to say, "I look back to my college life with great satisfaction. I was a fair student of everything I was required to learn, and it does not now occur to me that I ever missed a recitation, or the chapel service at six in the morning, winter or summer. * * I have no recollection that during those four years I ever did a thing to make my friends blush, and their praises when I left college gave me courage to begin my first steps in the world."

During the year immediately preceding his graduation he began to look forward to his life work. His father and his step-father having been physicians, it was to be expected that his attention would be turned to the profession to which they had belonged. Accordingly he felt a strong desire to study medicine and surgery, and he attended a course of lectures on anatomy delivered by Dr. Warren, the father of one of his favorite classmates. He also read some medical books. But his step-father earnestly dissuaded him from attempting the profession, and induced him to give up all thought of it.

After his graduation in July, 1797, he remained in

Digitized by Google

the family of an aunt in Providence, Rhode Island, about three months. During the summer and autumn of that year, the yellow fever prevailed in Philadelphia. In November he came to Philadelphia to make it his permanent home, still undecided what employment he would select, but fitted in an unusual degree to enter upon any line of life, and to make for himself a place and a name. No thought of rest or of self-indulgence after his four years of intense application, diverted him from an earnest purpose to do what he could. He had been turned away from the profession for which he had a decided preference, and to which all his reading that was not scholastic had been directed. He felt no special attraction to any other, and the uncertainty of success in the legal profession, of which he had heard much, made him hesitate to select that. Without much reflection, therefore, he turned his attention to mercantile life, and requested Dr. David Jackson, his guardian, to apply to Cunningham and Nesbit, a firm of large shipping merchants in this city, to receive him into their counting house as an apprentice. Fortunately for himself, fortunately for the bar, and fortunately for the country, the counting-room was full, and the merchants had no place for him. It was then he made choice of the legal profession, and at his instance Dr. Jackson requested Mr. Jared Ingersoll to receive him into his office as a student of law. Mr. Ingersoll consented, and thus the work of life was determined. So narrowly did he escape a calling, to which he was

Digitized by Google

apparently not best adapted, and so Providentially was he led into the profession which he subsequently so much adorned. He had no friends in Philadelphia to advise him, none, at most, sufficiently acquainted with his peculiar qualifications to advise him judiciously, though he had been told by his step-father that if he selected any of the learned professions, it ought to be the law.

Among his fellow students in Mr. Ingersoll's office were John B. Wallace, who afterwards married his sister, and John Sergeant, both young men of remarkable mental force, and of indomitable ambition, and both of them were, from the commencement of his apprenticeship, his life long friends. Somewhat later he contracted an intimate friendship with Mr. Charles Chauncey which continued unbroken until the latter's death.

How faithfully he improved the opportunities which Mr. Ingersoll's office afforded him may be inferred from what he had done in college, and may be known from what he was after his call to the bar. He had learned to study, and in study, not in mere reading, he found his chief delight. Of course to him the new science to which his attention was directed, presented attractions above everything else. His steadfast effort was to learn his profession accurately. With this he suffered nothing to interfere, and he firmly resisted all the social temptations which assail young men in large cities. He had resources for recreation within himself.

Digitized by Google

He was extremely fond of music, playing well upon the flute, and singing with great sweetness of voice. Indeed, to the last days of his life music was to him a great joy, and in the education of his children he sought attentively to give them musical accomplishments. The two years and more which he spent in Mr. Ingersoll's office were passed with great advantage to himself, and he never forgot the debt of gratitude he owed to his preceptor. In after years he paid it to that preceptor's memory in a manner that delighted the bar, and set up an enduring monument of his own respect and affection.

Having completed his apprenticeship, Mr. Binney was admitted to the bar of the court of Common Pleas on the 31st day of March, 1800, though he was then but little over twenty years of age, and at the March Term of 1802 he was admitted to the bar of the Supreme Court of the State. At the time of his admission the Supreme court consisted of Shippen, Chief Justice, and Yeates, Smith and Breckenridge, associate justices. Before these men he made his first appearance in the highest court of the State, and from them he received a kindly treatment that he never failed gratefully to remember.

In the year 1800, and through the early part of this century the eminent men who led the legal profession in the city were William Lewis, Edward Tilghman, Jared Ingersoll, William Rawle, William Tilghman, and Alexander James Dallas. To these may be added Mr.

Digitized by Google

Duponceau, distinguished especially by his knowledge of admiralty law. They were men of varied accomplishments, but they were all men of power, conspicuous in the city and throughout the State, and to them was entrusted nearly the whole of the important legal business of the community. To a young man just entering the profession, the prospect of success in obtaining employment may have seemed gloomy. The business community, who most need the assistance of lawyers, were supplied, and well supplied. There seemed to be no room for other lawyers, and those who occupied the field were too strong in themselves, and too strongly entrenched in the confidence of the public, to be displaced. In truth, however, the circumstances that might have been thought to interpose almost insurmountable obstacles to professional success were adjuvants to it. The well-prepared and ambitious young men, who, on their admission, found at the bar a body of practitioners so eminent as were those I have named, monopolizing the honors and the emoluments of the profession, were taught at once to lift their own standard high. They learned that no moderate attainments, no half-hearted efforts, no imperfect preparation would meet the necessities of their case. They grew indeed for a time in the shade, but it was a healthy shade. The exhibitions of mental power, of legal learning, and of professional skill which they constantly witnessed were instructive to them, the subjects of their thought and conversation, and incentives

Digitized by Google

to severer study. It cannot be doubted that no inconsiderable portion of the power and skill of Mr. Binney, Mr. Sergeant, Mr. Chauncey and others who honored the Philadelphia bar, and gave it a wide reputation during the first half of the present century, was due to the fact that at the commencement of their professional life, they were introduced into association with the leaders of the old bar, a body of men who would have graced Westminster Hall in its palmiest days. They may have thought their apprenticeship hard and long, but it yielded abundant fruit.

Mr. Binney was not discouraged by the outlook. With a resolute will, with patient waiting, and with unintermitted devotion to study, he bided his time—and it came. His success in obtaining employment was not speedy. For six years after his admission to the bar, he had a most meager clientage, and, as he remarked afterwards, his porridge would have been very insipid, if he had had to buy salt for it with what he made at the bar. But the time was not lost. He employed it largely in waiting upon the courts, and watching the course of trials, a practice which he afterwards often commended to young men, assuring them that, if attentive, they would learn as much in court as they could in their offices, during the same hours, and that what they learned would be more useful to them in acquiring the art of managing causes.

In April, 1804, he was married to a daughter of Col. John Cox, of Trenton, New Jersey, an efficient officer

Digitized by Google

in the quartermaster's department during the revolutionary war, and the union thus formed continued through the long period of sixty-one years, until her death.

In the year 1806 he was elected a member of the legislature of the State. He served as such, however, but a single year, declining a re-election. While he was a member, one or two memorials of the Chamber of Commerce and one for the incorporation of The United States Insurance Company were committed to his charge. These brought him into association with the merchants and underwriters of the city, and so satisfactory was his management of the trusts committed to him, that immediately after the close of his membership much professional business relating to insurance flowed in upon him. To Mr. Edward Tilghman, one of the leaders of the "old Bar," he was indebted for his launch into this department of practice. Mr. Binney has himself given an account of his start in his most interesting sketch of three of those leaders. The case committed to his sole charge by the advice of Mr. Tilghman was "Gibson vs. The Philadelphia Insurance Company," reported in 1 Binney, page 405. It was one of difficulty, and it involved the application of principles not familiar to most members of the profession even at the present day. The report shows that it was very ably argued by him, and with success. It was the second case which he argued in the Supreme Court of the State, and it was the beginning

Digitized by Google

of the large success for which he had waited so long, and for which he had made such thorough preparation. The insurance business was never, perhaps, better, at any time, or at any bar, than it was in Philadelphia, from 1807 to 1817, including the ten years between his substantial entrance into practice, and his attainment of the full reputation and employment which he held undiminished during his continuance in professional life.

In these years, pressingly engaged as he was in professional duties, he prepared and published his six volumes of reported decisions of the Supreme court of Pennsylvania, covering the period from 1799 to 1814. To this work he was invited by Chief Justice Tilghman, soon after his return from the legislature. That he received the invitation from such a source, before he had obtained any considerable practice, and when he was only twenty-seven years old, was a very high testimonial to the confidence which his abilities, his culture, his habits and his character had won for him in the best quarters. Mr. Edward Tilghman's faith in him, as exhibited in the incident to which I have referred, illustrates the respect he had gained from the leaders of the "Old Bar," whose judgment was not likely to err. Of his reports I must make only brief mention. Fortunate would it be for any court of last resort, and fortunate for the legal profession, if all reports had equal merits. Certainly throughout the six volumes the reporter gave irrefragable proofs of his

Digitized by Google

ability to comprehend legal arguments, and to restate them with clearness in a condensed form. His analysis of the facts upon which the judgments were rendered, was rigid and accurate, and his head notes expressed exactly what the court decided. No complaints have ever been made that his syllabus was not sustained by the case. When the reports came from his hands they left nothing to be desired. They must always be regarded as the work of an accomplished lawyer. It is not an easy matter to report well, and it is very rare that any reporter gives full satisfaction to the court and to the bar. The art requires not merely fairness, accuracy, and ability to comprehend what was argued and decided—it requires all that and more. It demands ability to gather from the mass of facts in the record those that really constitute the case, and to state them lucidly, omitting all that are not material, and overlooking none that are. It demands also power to extract from the opinion of the court the legal principles adjudged to be applicable to the facts, and to restate them in short, and with perfect accuracy. By the universal judgment of the profession, such a reporter was Mr. Binney. His authorship, as a reporter, ceased in 1814 on the publication of his sixth volume.

After 1807 his professional engagements were very large, not only in insurance cases, but in all kinds of important business. He seemed to pass at one bound from his long apprenticeship in waiting into acknowl-

Digitized by Google

edged leadership. He divided the business of the courts with the eminent men who, when he came to the bar, held all that was worth holding. How great his share became, and how completely he won the confidence of the business community, as well as that of his professional brethren, may, in some measure be discovered by an examination of the reported decisions of the Supreme Court of the State, of the Supreme Court of the United States, and of the Circuit Court of the United States for this district. His work appears in Binney's reports, in those of Sergeant and Rawle, Rawle, Penrose and Watts, William Rawle, in Washington's Circuit Court reports, and in those of Cranch, Wheaton, and Howard. His engagements in the local courts, and in his office were correspondingly large.

He was favored by the privilege of conducting most of his cases, and making most of his arguments in the Supreme Court of the State before a Chief Justice who presided there more than twenty years while he was in full practice, and for whose abilities and personal character he had unbounded veneration, and even affectionate regard. He knew also that he in turn enjoyed the fullest confidence of that most excellent magistrate. The advantage of such relations between an advocate and the court he addresses can hardly be over-estimated. In the Federal Circuit Court for this district, where Judge Washington presided, about thirty years, and in the Supreme Court of the United States under Chief Justice Marshall, he enjoyed similar advantages.

Digitized by Google

I do not propose to call your attention to any of the cases in which he was engaged, though many of them were of much interest. Grateful as the work would be, I have not time for its performance.

In reference to his arguments, however, I make a single remark. Some of them have been preserved by the reporters in a condensed form. To estimate them justly they should be compared with the condition of legal knowledge and legal reasoning when they were made. And when thus compared, many of them, I think, will be found to have been, in exact exhibition of legal principles, and of the reasons upon which those principles rest, much in advance of what was generally known, and in advance even of what had been expressed in judicial decision.

The war of 1812 brought with it the usual fruits of war: destruction to commerce, embarrassment to trade, rash speculation, and consequent profit to the members of the bar. Unhappily their direct interests are rarely injured by national adversity. This, perhaps, is one of the "principal deductions from the general popularity of the profession, and one of the reasons why it receives more respect than love," without fault of its own. Mr. Binney shared largely in that profit, and the close of the war in 1815, found him in possession of all that the profession of law could give to its professor, whether of reputation or emolument. The eminent leaders of the bar, whom he encountered at his entrance into the profession, had, in a great

Digitized by Google

degree, retired from active business, and, soon after, most of them departed from life. The field was clear, and, with the exception of Mr. Sergeant and Mr. Chauncey, his constant friends, he was almost without a rival. But this caused no relaxation of his energy. The habits he had formed in college, his love of study for study's sake, and his deep-seated convictions of duty to his clients, with an ever-abiding sense of obligation to them, overcame all tendency to inertness, if any ever approached him, and he continued till the close of his professional life as heartily devoted to it, and as mindful of its claims, as he was in the first flush of his manhood.

He had one cardinal principle upon which he always acted, and which he regarded as the secret of his success. It was to attend to no calling but his profession, knowing that if that were attended to, it would do all for his family and enough for himself. He listened, no, not for a moment, to any invitations, (and many were given him,) to speculate in stocks, or in real estate, or to take part in any kind of trade. He felt it impossible for him to do so without neglecting the practice of the law, which, if faithfully pursued, he was assured would be better than any, or all things else. Guided by this principle he resisted calls to public life. Before he was fifty years old, he had been twice offered a seat on the bench of the Supreme Court of the State, and once, at least, if not twice, he was tendered a commission to be a judge of the Supreme Court of the

Digitized by Google

United States. All these offers he promptly declined. It was not because he did not value distinction, and not because he did not know his own superior fitness for the posts offered, but he valued excellence above place, and his chosen road to excellence was the path he had marked out for himself at the commencement of his career.

Yet, though he would not suffer himself to be diverted from entire devotion to his profession by office, or by seductive hope of gain in other directions, he did not decline calls that he thought consistent with that devotion. In 1808, when only twenty-eight years of age, he was chosen a director of the first bank of the United States. This appointment he accepted, and he continued to act as a director and a trustee very many years. It was in the service of the bank he argued his first case in the Supreme Court of the United States. The case was The Bank vs. Deveaux et al., reported in 5 Cranch, page 61. No one can read his argument, condensed as it is in the report, without admiring its orderly arrangement, its reach and its logical power. It was the effort of a lawyer well trained and well furnished.

In 1827, Chief Justice Tilghman died. He had in 1806, succeeded Chief Justice Shippen in the headship of the Supreme Court of the State, and he remained its head during the long period of twenty-one years. It was under his administration that the law of the State had grown into an orderly and well adjusted sys-

Digitized by Google

tem, that the common law of England had been accommodated to the novel circumstances of our people, that the land laws of the State had been reduced to an intelligible code, that our mingled system of law and equity had been developed, and that many of the most important rules of property had been established. To the work of educing such results he was admirably adapted by the structure of his mind and its high culture, by his wise and broad common sense, by the comprehensiveness of his views, by his conscientious devotion to his official duties, and by a purity of character that never bore a spot. He was a man after Mr. Binney's own heart. They were kindred spirits. Under his administration of the law, Mr. Binney had grown into all his greatness and fame, and he felt, as few could feel, how great a debt of gratitude the bar and the state owed to the memory of the deceased magistrate. No wonder then, that, when invited by the bar to pronounce an eulogium of the Chief Justice, he poured out from a full heart, and from the stores of an accurate and discriminating observation, the remarkable discourse contained in the 16th volume of Sergeant & Rawle's Reports. It was not the utterance of respect and affection alone. The discourse exhibits a careful analysis of intellect and character, a just appreciation of what gave to the Chief Justice his power and his usefulness, and an admiring estimate of his moral worth. It is a photograph of that great and good man so life-like that it cannot deceive, so deeply

Digitized by Google

wrought that it cannot fade, and rendered doubly attractive by the inimitable style in which it was executed.

About the year 1830, after severer exertions than were usual, Mr. Binney's health began to be impaired, and he desired to withdraw gradually from the courts, and throw off, in considerable measure, the load of business with which he was oppressed. It was this, in part, which made him willing to accept a nomination for Congress. There were doubtless other reasons that influenced him. Principal among these was the hostility of President Jackson to the Bank of the United States. His veto of the bill for its recharter in 1832, aroused the deepest feeling of its friends, who then constituted most of the business community of this city. Mr. Binney was one of the number, and his transcendent ability, together with his well-known knowledge of the condition and operations of the bank, pointed him out as the best man to defend the institution in Congress. All eyes turned to him, and his services were at once demanded. Believing as he did in the great usefulness of the bank, and in its necessity for the public welfare, he did not feel at liberty to decline the call. He was elected, and he took his seat as a member of the twenty-third Congress on the 2d of December, 1832. That Congress was filled with distinguished men, many of them, longed trained in the public service. Mr. Binney took into it a great reputation, such as few lawyers ever brought into Congressional life. Much was expected from him, and all

Digitized by Google

that was expected was realized. If he found any equal, he found no superior. He never stooped to the arena of partisan discussions, but in the consideration of important subjects, especially that of the removal of the public deposits from the Bank of the United States, he proved himself to be a statesman of high rank, and a most accomplished debater. Though but two years a member, he has left at Washington a most enviable reputation. The old men who naturally recur to olden times, speak of him as one of the giants of the past, and worthy to be associated as a statesman and an orator with the triumvirate that so long adorned the American name.

But public life was extremely distasteful to him. He turned his back upon it with gladness. "Public reputation," said he, "is generally empty, and oftentimes false, but the respect and affection of one's own kindred and personal friends, ah! that is delightful." Declining a re-election, he returned to Philadelphia, and retired from all professional practice in the courts. In the year 1836 he went to Europe because of the ill health of a member of his family, and only once thereafter did he ever appear in any court as an advocate or a counsellor. He continued, however, to give opinions in his office until 1850. Many of these opinions, written by him, are still in the hands of members of the bar, and they are preserved with almost religious care. They relate to titles to real estate, to trusts and uses, to commercial questions, and to all

Digitized by Google

questions in every department of the law, that are most intricate and difficult of solution. They are model exhibitions of profound and accurate knowledge, of extensive research, of nice discrimination, and of wise conclusion. They have been generally accepted, as of almost equal authority with judicial decision, and not unfrequently, a claim set up with confidence has been abandoned when it became known Mr. Binney had given an opinion adverse to it.

In the year 1835 he was invited by the Select and Common Councils of the city, to deliver a discourse on the life and character of Chief Justice Marshall. That distinguished magistrate had shortly before gone down to his grave, full of years and of honor, and had left behind him a nation of mourners. He was appointed Chief Justice of the Supreme Court of the United States, by President Adams, in January, 1801, and he continued to preside in that Court during the long period of thirty-four years.

Providence smiled upon our infant nation when he was appointed. The Constitution was then an untried experiment. It had no precedent. It remained to be interpreted, and what principles of interpretation ought to be applied to it, whether a strict or a liberal construction should be adopted, or whether a more rational view should be taken of it, one neither strict nor liberal, but consonant with the paramount intent of those who framed it, and necessary to secure the objects for which it was designed, remained to be determined. It

Digitized by Google

was quite possible to make a mistake, and mistake might have brought early shipwreck to our institutions. Happily, Chief Justice Marshall proved himself equal to the demands of the time. Aided by associates, themselves able, but who deferred much to his judgment, he laid down principles for constitutional construction which have made our government what it is; which have been accepted since his death without question, and which have given stability and efficiency to the Federal Union. With sufficient knowlege to meet the necessities of his position, with powers of reasoning of the highest order, with a comprehensiveness of view rarely equalled, and with a patriotism that never faltered, he met the questions presented, and did his great work. To use the words of Mr. Binney, "He looked through the Constitution with the glance of intuition. He had been with it at its creation, and had been in communion with it from that hour, * *. Both his judgment and affections bound him to it, as a government supreme in its delegated powers, and supreme in the authority to expound and enforce them, proceeding from the people, designed for their welfare, possessing their confidence, representing their sovereignty, and no more to be restrained in the spirit of jealousy within less than the fair dimensions of its authority, than to be extended beyond them in the spirit of usurpation. These were his constitutional principles, and he interpreted the Constitution by their light." The life and services of such a man were a theme worthy of Mr.

Digitized by Google

Binney's powers. How well he performed the duty assigned to him, I need not say to the bar of this city who heard him, or who have read his discourse. He performed it "con amore." He knew the Chief Justice well. He accorded with him in his principles, admired his private character, and reverenced his judgments. In him he found powers and principles like his own, and by his eulogy he spread, in clearest light, before those who heard him, the qualities of mind and heart that made the Chief Justice both great and good. He depicted in unfading colors what the great magistrate had done, and held him up to that age and to all future time as an immeasurable benefactor to the country.

In 1844, by appointment of the City Councils, Mr. Binney argued in the Supreme Court of the United States, the case of Vidal *et al.* *vs.* Girard's executors (reported in 2 Howard, p. 127), in which was involved the validity of the trust created by Mr. Girard's will for the establishment and maintenance of a college for orphans. The case had been argued at a previous term, by Mr. Sergeant, and it is said that, discouraged by the apparent uncertainty remaining in the minds of the judges, he asked for a re-argument. Whether this was so, or not, a re-argument was ordered, and Mr. Binney, though years before he had withdrawn from the state courts, accepted the appointment of the City Councils, and argued the case anew. Of his argument I have no space or time to speak as it deserves. The

Digitized by Google

remembrance of it lingers around the court room until this day. It is in print, and it has ever been the wonder and the admiration of the legal profession in this country, and almost equally of the profession in Great Britain. It lifted the law of charities out of the depths of obscurity and confusion that covered it before, and while the fullness of its research and the strength of its reasoning were masterly, it was clothed with a precision and beauty of language never surpassed. No wonder it was successful. It was a fitting close to a long and pre-eminent professional life. Mr. Binney never afterwards appeared in court, though he continued for some years to examine legal questions submitted to him, and to give written opinions. At length the calls upon his attention became so numerous as to be oppressive. The examinations they required were trying to his eyes, which after 1832, frequently suffered from inflammation. For these reasons, in 1850, he withdrew entirely from all professional labor. Thus relieved, his eyes recovered their strength, in good measure, and they continued to be of service to him ever after.

But, with leaving the profession, he did not abandon his habits of study. Released from the demands of a jealous and laborious pursuit, he turned with new zest to what had ever been to him a delight. He always had a vigorous appetite for the best literature, especially for that which was moral and religious, and this appetite increased as he grew older. He was a good

Digitized by Google

Spanish scholar, and proficient also in the French language. Books in both French and Spanish he was fond of reading, as also History, Metaphysics, Poetry (especially dramatic poetry), and Theology. Of the latter subject he was a close student. He was a firm believer in the truths of divine revelation and an habitual reader of the Bible. He carefully read also many of the most important opinions of the Supreme Courts of of the State and of the United States, and some English decisions. He kept himself well informed of the current events of the day, and in regard to all public questions that agitated the city, the state, or the country, he not only sought information, but he matured settled opinions. To such employments he devoted mainly his time and attention after his complete retirement from professional life. Many years afterwards, when speaking of this period of retiracy, he said "his objects had been, *first*, to keep himself from rusting out by such occupations intellectual and bodily as would keep him in reasonable tune, while the decays of age were gradually impairing the old sounding board, *second*, to continue useful to his family, as it was arriving at years of maturity, and would look for settlement in the world, *third*, to be useful to the world, so far as should be in his power, without becoming denatured, by a public part in the various avocations, religious, literary, social, political, philanthropical, national and municipal which distinguished the times from those which preceded them, and, *fourth*, to prepare for the

Digitized by Google

final event, by availing himself of all the means which God had graciously vouchsafed to him." "Progress in this sense," he added, "is private, public, temporal, eternal;" "spreads undivided, operates unspent," "comprehends the performance of all duties in such measure as is consistent with all, and ends in that perfect stature which all should endeavor to obtain, though so few attain to it."

The activity of his mind remained undiminished until his death. He was constantly occupied, though not always, in the indulgence of his fondness for reading and study. Occasionally he made a rich contribution to the enjoyment and instruction of the public. In 1849, at a meeting of the members of the bar, convened after the death of Mr. Chauncey, and at a similar meeting in 1852, soon after the decease of Mr. Sergeant, he gave utterance to his estimate of those distinguished men, with remarkable analyzation of their mental and moral characteristics, and in words all aglow with the warmest friendship. The meeting in reference to Mr. Sergeant's death was the last occasion of his distinctive association with his professional brethren. He never again appeared at a bar assemblage. Once only afterwards, (so far as I have learned,) did he allow himself to be prominent on an entirely public occasion. It was on the 22d day of February, 1860, when in response to an invitation of the City Councils, he read before those bodies assembled in joint meeting, Washington's Farewell Address. In

Digitized by Google

addition to the members of the Councils, a few invited friends were present. Mr. Binney, then eighty years of age, stood on the platform in the Common Council chamber, and read the entire address, with a firm voice, and with expressive emphasis. When he had concluded, silence ensued in the chamber, the audience evidently expecting some remarks from him. He was much affected, and after pausing awhile, he said, "and thus closes the noblest compendium of fatherly affection, patriotism and political wisdom the world has ever seen. No words of mine are fit to stand beside it." In the year 1852, at the one hundredth anniversary of The Philadelphia Contributionship for the insurance of houses from losses by fire, he delivered an address on the history of fire insurance, and upon the principles adopted by that association. Like everything which came from him, the address exhibited the completest understanding of his subject, great felicity in its mode of presentation, and a vigor and beauty of expression unsurpassable. It is read with pleasure and with profit even now. In the following year he published a valuable and suggestive article on the naturalization laws. In 1858 he gave to the public a sketch of the life and character of Bushrod Washington, a Judge of the Supreme Court of the United States, who for many years presided in this circuit with great honor to himself, and usefulness to the country. In his court, Mr. Binney had very constantly appeared, in the conduct of most important causes, and there had

Digitized by Google

grown up between the Judge and the lawyer mutual regard, and even affectionate admiration. These feelings and sentiments found unrestrained expression in the sketch, and therein also, he delineated, with his wonted acuteness, the qualities which make up a perfect *nisi prius* judge, nowhere else better, if as well, described.

In the same year (1858) he published those exquisite descriptions of three leaders of the old bar of Philadelphia, which are still read in this community with intense interest, though the men described belonged to a generation long gone past. The freedom of the writer from all envy or jealousy; the generous appreciation and acknowledgment of true and varied excellence; the searching analysis of intellect and character, and the graceful presentation of each subjects individuality which the descriptions exhibit, have compelled admiration alike in this country and in England where they were reviewed by Sir John Coleridge, with expressions of warm admiration alike of the sketches, and of the author.

In 1858, also, he gave to the press a more extended discussion, entitled "An inquiry into the formation of Washington's farewell address," which is not only curious and interesting, but strikingly illustrative of the character of his mind, and of his habits of thorough investigation, and of reasoning. It is mainly a treatment of evidence, coupled with a description of conflicting probabilities. From it one who never knew him in the

Digitized by Google

exercise of his profession, may learn how careful and minute was his search after facts, how calmly and wisely he arranged every fact discovered in its proper relation to all others, giving to each its due weight, how inevitably his deductions seemed to flow from his premises, and how precise and perspicuous was the language he employed. No one, I think, can rise from its perusal without a thorough conviction that its conclusions are absolutely correct, and that the opinions that prevailed before its publication were, all of them, more or less, erroneous.

One other product of his thoughts he gave to the public. During the progress of the civil war, the President of the United States, under the pressure of what seemed a real necessity, suspended the privilege of the writ of *Habeas corpus*, without any authority given by Congress, claiming that by the Constitution, and from the nature of his executive office he was invested with the power to suspend the privilege, in cases of rebellion or invasion. As might have been expected, his act immediately called forth much unfavorable criticism, and his power to do what he did, in the absence of Congressional authority, was in many quarters, strenuously denied—in all quarters, perhaps, at least doubted. It was then (in 1862) that Mr. Binney turned to the consideration of the subject, and gave to the public an argument in support of the power claimed by the President, not less remarkable than the best of his earlier efforts. This is not a proper occasion to pronounce

Digitized by Google

judgment upon the correctness of his conclusions. Of the argument itself, however, I may speak. It was thoroughly original, and it was constructed with a force and elegance that won admiration, even where it did not command assent. It is contained in three pamphlets published successively in 1862, and 1863. They will never cease to be regarded as models of acute reasoning applied to constitutional law.

To such labors and employments Mr. Binney devoted the later years of his life. They were happy years, crowned with habitual cheerfulness, though not unmingled with sorrow. In 1865 Mrs. Binney, his companion through all his early struggles at the bar, and through the period of his highest success, was removed by death. And in 1870 he suffered another severe affliction in the death of his oldest son, Horace Binney, Jr. That son was himself pre-eminent in mental and moral culture, in soundness of judgment, in refinement of taste, in goodness of heart, in true piety, and in all that adorns and ennobles human nature. The father and the son were companions to each other, kindred in spirit as well as in blood. Their mutual confidence was perfect, and consequently their intercourse with each other was a source of intense happiness to both. This was but a natural result of the attention the father had given to the son's training. During the four years the latter was in college, the closest intimacy was kept up between them by a weekly, and at times, a semi-weekly correspondence, in which the father encouraged the

Digitized by Google

son to perfect confidence in him, and in return gave the benefit of his counsel with a loving interest. The correspondence was never permitted to flag, though Mr. Binney was then at the height of his professional practice, bearing a heavy pressure of business both in and out of court, and superintending a large class of law students, whose examinations he always conducted with regularity and strictness. It was guided by his advice, and in the light of his example and character that the son grew into full manhood, and in the later years of his life the relations between him and his father became more than filial and paternal. They were almost fraternal. The father leaned upon the son, reposed full confidence in him, regarded him as his strongest earthly prop, and looked to him as the one to fill his place after his own last summons should come. How great the sorrow which the son's unlooked for removal, in the fullness of his usefulness, and of the high estimation in which he was held by the community, must have brought to the father's heart cannot be told. Mr. Binney was then more than ninety years old. The shock of such a bereavement might well have been fatal. But the blow did not crush him. He felt it most keenly, but with submission to the will of Divine Providence, he resolutely addressed himself to the new and unexpected duties cast upon him. These having been performed, with his attention more and more turned toward the final event that awaited him, and with a cheerfulness of dis-

Digitized by Google

position that knew no abatement, he continued to live in the midst of his books and his thoughts, the delight of his family, and the charm of all those who enjoyed intercourse with him until the 12th day of August 1875, when he peacefully passed from this life into a world where his splendid intellectual powers will forever expand, and where his moral excellence will never cease to grow.

His death occurred forty years after the age when most men are at the zenith of their reputation; forty years after he had substantially withdrawn from public view and from active participation in all matters that attract general notice, and at the end of a period when public recollection of most lawyers has faded into indistinctness, yet it would be difficult to mention a death that caused a sensation more wide spread and profound than his. Not alone in this city, or in this state was it felt that a great luminary had been extinguished, but the legal profession of the whole country acknowledged the bereavement, and many unprofessionals hastened to declare their loss.

I have thus given an outline of the life and labors of this remarkable man. In looking over it I see there is much that ought to be filled in, and some things that deserve particular notice.

He was a most accomplished lawyer. This, perhaps, might have been expected from his mental endowments, and from the habits of study that he acquired in early life. But he surpassed expectation. I

Digitized by Google

know of no language which so aptly describes him as that which he applied to Mr. Edward Tilghman, the friend of his youth: "He was an advocate of great power; a master of every question in his causes; a wary tactician in the management of them; highly accomplished in language; a faultless logician; a man of the purest integrity and the brightest honor; fluent without the least volubility; concise to a degree that left every one's patience and attention unimpaired, and perspicuous to almost the lowest order of understanding, while he was dealing with almost the highest topics."

He had great advantages, none of which were neglected. Besides the opportunities his collegiate course afforded him, and which he improved to the uttermost, besides the art and habit of study he early acquired, he had examples of excellence before him which it was not in his nature to disregard. He was trained to be a legal tactician by his constant attendance in the courts before he was called to assume the management of causes. He thought logically and spoke and wrote the purest of English before he came to the bar. He had a fine commanding person, an uncommonly handsome face, a dignified and graceful manner of address, and a most melodious voice, perfectly under his control, and modulated with unusual skill. He was constitutionally an earnest man, yet while earnest, he had a calm self-possession, the fruit of consciousness that he fully understood his subject, and of confidence that he could make

Digitized by Google

others understand it, and he entered upon the trial of his causes with a sure conviction, confirmed by his previous study, that he was advocating the right. No unjust or dishonest case would he willingly undertake, and he was able to say after his career at the bar had closed, that "he had never knowingly committed an injustice toward a client, or the opposite party, or prosecuted a cause that he thought a dishonest one, and that he had washed his hands of more than one that he had discovered to be such after he had undertaken it, as well as declined many which he perceived to be such when first presented to him." Add to this the power of a mind equal to the comprehension of any legal subject; a mode of presentation the best possible; a rhetoric that was faultless; an aptness of illustration that illuminated the most abstruse matters; a personal character without a visible flaw, and it is easy to see he must have been, as he was, a most persuasive and convincing advocate.

He won the confidence of courts and juries by his entire freedom from trick, or any of the low arts of cunning. He disdained to practice any stratagem or artifice for the purpose of obtaining an advantage over an adversary. His nature was true, and his life was truth unfolded. He was always candid, giving full consideration to whatever made against him. He appealed to no prejudices, but rather boldly met, and endeavored to dissipate them. He was ever courteous in his demeanor towards the court, and towards his op-

Digitized by Google

ponents. Thus every element of power, in mind, in culture, in habit, in physical endowment, in taste, in demeanor, and in character, was his. All united in giving to his forensic efforts an efficiency, and a success inferior to those of no other. Our brethren that remain, who saw him at the bar, speak of him as ever maintaining a dignified decorum, and a manner not reserved or cold (though perhaps apparently such at times), but genial and good humored toward his professional brethren, and respectful to the bench. They speak of him as above the suspicion of rhetorical arts, or partisan strategy. They say his appeals were to the judgment rather than to the passions; that his action was graceful; that he never sought to make a display of oratory though he was always eloquent in thought, and winning in diction. He was never heard without instruction, never without pleasure.

He had some other characteristics that deserve special mention. In everything he undertook he was thorough to the highest degree. Thoroughness was a habit of his life. He brought it to all his investigations, and he regarded it as a duty never to be slighted. In his view it was criminal to neglect the fullest possible preparation for the trial of every cause committed to his care, or for any opinion he was called upon to give. One of his maxims, often commended to others, and always acted upon by himself was "Work up to power." Whatever came from him was, therefore, the best he could produce, and those who

Digitized by Google

followed him rarely found any thing that had escaped his notice, or his thought. What he did not make use of was, in his judgment, of no importance, and therefore entitled to no consideration. It was not unnoticed because unknown. And it was never safe to treat as of little worth any position he took. His mind at once seized all the facts and the principles applicable to them, and discarded all that, after careful thought, he deemed immaterial, or inapposite. He was never surprised by any thing against which the extremest vigilance could guard. Hence nothing immature, nothing unfinished ever came from him in argument, or in essay. Nor was he thorough only in his profession. He carried the habit into his general reading, both literary and scientific. Whatever he knew, he knew throughout. No chamber of it, however remote, escaped his exploration. He gathered from every book he read all the thoughts worthy of being preserved, and made them subjects for his own reflection, recurring to them from time to time for renewed consideration.

His reading was so extensive that he made constant use of helps to return to passages which had most interested him. He was therefore a great admirer of a good index. I say index, not digest. His estimate of such an index was expressed in a letter to a friend, written when he had passed his eighty-sixth year, wherein he said: "I must say in reference to indexes generally, that I have come to regard a good book as curtailed of

Digitized by Google

half its value, if it has not a pretty full index. It is almost impossible without such a guide, to reproduce on demand the most striking thoughts or facts the book may contain, whether for citation, or further consideration. If I had my own way in the modification of the copyright law, I think I would make the duration of the privilege depend materially on its having such a directory. One may recollect generally that certain thoughts or facts are to be found in a certain book; but without a good index such recollection may be hardly more available than that of the cabin boy, who knew where the ship's tea kettle was, because he saw it fall overboard. In truth a very large part of every man's good reading falls overboard, and unless he has good indexes, he will never find it. I have three books," said he, "in my library which I value more than any other three, except the very books of which they are a verbal index; Cruden's Concordance of the Bible, Mrs. Cowden Clark's Concordance of Shakespeare, and Prendergast's Concordance of Milton." The estimate of good indexes thus expressed illustrates how earnest was his search for truth and knowledge, and how reluctantly he let go any of his acquisitions.

Mr. Binney's thoroughness was accompanied by strictly methodical habits. He had a place for every thing and everything had its place. The arrangement of his briefs, of his papers and books, and equally of his stores of knowledge and thought was perfectly systematic. It was this that enabled him ever to pro-

Digitized by Google

duce on call, the facts of which he had acquired knowledge, and the thoughts he had matured, together with the illustrations needed, and to fortify what he produced by apt quotation of authorities.

Of his judgment, I find it difficult to speak in fitting terms. It seemed to be intuitive, yet its conclusions were cautious deductions of sound reason from a most comprehensive and accurate view of the facts, alike in detail, and as a whole, and from a wise selection of the principles properly applicable to the state of the facts as he found them. He brought to every subject submitted to him the calmest consideration, unbiassed by prejudice or pre-conceived opinions, and he gave true weight to whatever bore upon it. Hence the decisions of his judgment were never narrow, and almost never wrong. He was a most wise and safe counsellor at the bar, and in every circle where his counsel was sought.

He was a man of great moral courage. When he had matured his convictions of the right, he was not to be driven from their avowal by any fear of consequences. He was a resolute and fearless supporter of law and order in the community. When the Kensington riots threatened to uproot the foundations of society in the northern part of the city; when the law was temporarily overthrown, and its officers were powerless to resist the outbreak; when "men's hearts failed them for fear," and many thought only of submission or compromise, he stood firm. He bent not be-

Digitized by Google

fore the storm. It was he more than any other who inspired confidence. It was he that restored courage to many who were faint-hearted; that gathered around him the virtue and intelligence of the city, and led in bringing back the supremacy of the law. And when, in later years the foundations of our government seemed crumbling away; when civil war threatened the subversion of our cherished institutions; when attachment to party, with very many, prevailed over love of country, Mr. Binney, an old man of more than fourscore, stepped forward, and placed all his influence and the weight of his great name in the scale of a tottering government. Nor was there ever an occasion when high moral courage was demanded, when the city was in trouble and needed a leader and adviser, that he was called upon and failed efficiently to respond. He was often resorted to in seasons of perplexity, and never was application made in vain. Even when not consulted, the friends of good order, and of the right were encouraged by the fact, of which they needed no other evidence than his life, that he would always be found on the side of the just, the orderly, and the true.

Though he was not long in official life, he gave the fullest proofs that he was both a patriot, and a statesman of high order. The evidence is to be found in the opinions he expressed in Congress, and in those which from time to time he gave to the public while he was in private life. He understood thoroughly the organi-

Digitized by Google

zation and action of both the State and General Governments, and he was familiar with the whole science of constitutional law. He was in the main a conservative, though not averse to healthy progress. According to the division of parties existing soon after the adoption of the Federal constitution, he was ranked as a Federalist. He adopted the views of the constitution held by Washington, Hamilton and Marshall. To these he adhered during his life, and he made no secret of them when they became unpopular. On the 14th of January, 1872, when writing to a friend, he said: "You know I am the residuary legatee of Washington Federalism. I am not, however, without a great many younger men who are *haeredes instituti*, though *post nati*." But, though a conservative, he approved of changes that he thought improvements. He did not think all changes progress, though he recognized that progress means change. He conceded that the advance of civilization demanded a change of laws in many particulars, and of organic law in some. Still he was not a friend to any changes hastily made; changes that might bring evils in their train not less than those they were intended to cure. Not lacking confidence in the masses of the people, he yet thought it a great mistake to subject the judiciary to dependence on a popular vote. With a high estimate of its importance to the stability of our institutions, and to the correct administration of law between man and man, he deprecated every scheme that threatened diminution to its

Digitized by Google

independence, and tended to drag it down into the mire of party politics. He favored the consolidation of the City of Philadelphia, as tending, in his judgment, to the promotion of good order, and to the general reform of subsisting abuses, and he lent his influence to send to the Legislature the men of "experience in civil affairs, of general knowledge, talents, integrity, moral courage and conscientiousness" through whose agency consolidation was effected.

Immersed as he was all his life in a flood of occupations, and unwilling while he was engaged in the practice of the law, to be diverted from it by any hope of gain to himself, he felt a deep interest in many institutions cherished by the community, and in many of our noblest charities. He was one of the originators of the Academy of Fine Arts, and with forty other members of the bar he signed the articles of association. William Lewis and Judge Tilghman were also among the signers. Mr. Binney was the youngest. He was present at the first meeting in the Hall of Independence, to choose officers, and to launch the constitution of the society, and there he made an address. He was early connected with the Horticultural Society, and he was a member of the Franklin Institute and of the American Philosophical Society. He presided many years over the Apprentices' Library Company. He was long a director of the Pennsylvania Institution for the deaf and dumb, and he was a contributor to the House of Refuge. He felt great interest

Digitized by Google

in savings institutions, and in all agencies adapted to promote the thrift and comfort of persons in humble life, and he was associated with other public charities. He was also deeply interested in the benevolent institutions of the Church, to which he belonged, giving to them much of his time, his matured wisdom, and his pecuniary support. The most delicate, refined, and unostentatious charities seemed most to enlist his sympathies. He was a member of the corporation for the relief of the widows and children of clergymen in the communion of the Protestant Episcopal Church from 1831, until his death, and much of the time its President. To it, and to all other associations with which he suffered himself to be connected, he gave much more than his name. He gave his sound judgment, his wise counsels, and, whenever needed, his labor and his money. Their records are full of the evidences of his efficient services, and the touching minutes adopted by them after his decease, attest the value of his co-operation, and the strong hold he had upon the reverence and affection of his associates.

Mr. Binney's friendships were warm, and they were lasting. No envy or jealousy interfered to disturb their harmony. If ever broken, it was because his confidence was necessarily withdrawn. His addresses after the death of Mr. Chauncey, and Mr. Sergeant bear witness to the intensity of his affection for those friends, though more than all others, they had been his

Digitized by Google

rivals, and often opposed to him in the strife of the bar. In the last year of his life he said in a letter to a life-long friend " my wishes for your happiness are as constant as the return of my days." The tenderness of his love for children was remarkable, and it was often demonstrated. His affections never ceased to flow in warm currents towards the descendants of the friends of his youth, and he found some of his choicest pleasures in contributing to their happiness. His letters abound in outgushing sympathy with the joys and sorrows of the young, as well as with those of his older friends.

Of the light he was in his own dwelling, of the wealth of affection he exhibited there, and of his devotion to the happiness and to the mental and moral culture of his children, I will not speak.

He was an admirable conversationalist and correspondent. His mind and his memory were so full of the richest thoughts that they overflowed into his conversation and into his letters of friendship, and his power of expression was so ready and so chaste, his pleasantry was so genial, and his moral sentiments were so pure, that those who enjoyed correspondence with him will ever preserve his letters among their treasures.

It would be interesting to speak of the stores of observation gathered into his memory during his long life, and ready for his recall. He lived more than ninety-five years and a half, longer than any celebrated

Digitized by Google

lawyer of whom I have knowledge, either in this country, in Great Britain, or on the continent of Europe. He lived with unimpaired mental faculties, and generally in the enjoyment of good health, preserved and confirmed by temperate habits and regular bodily exercise. His adult life extended over the first three quarters of the present century, a period of advance, not of retrogradation. In it the world saw most remarkable changes. Empires rose and fell. Many new kingdoms and governments were established. Constitutional law made wonderful advances, and municipal law was accommodated to an altered condition of human affairs. The mechanical arts made unprecedented progress. New powers and agencies were discovered, more potent than any before known, and applied to daily use. Religious toleration advanced to be an accepted doctrine, and popular education came to be regarded as of inestimable importance. Society in very many particulars, was revolutionized, and civilization achieved greater triumphs than in any former equal period of the world's history. Of all these changes Mr. Binney was an attentive observer. It was not in his nature to be indifferent to them. He not only noticed the progressive changes, but he must have considered their causes, and their probable consequences. He was himself a link that connected the men of the revolution with the present generation. What an ocean of thought the events and changes of his life-time spread out before his declining years! And

Digitized by Google

how suggestive the memories must have been! But I may not pursue this speculation.

One other and the crowning glory of his life and character remains to be mentioned. He was an earnest Christian. I have already said he was a close student of Theology, a firm believer in the truths of Divine Revelation, and an habitual reader of the Bible. His confidence in the Divine inspiration of the Bible began in his youth, and gathered strength with his increasing knowledge of what it contains. He was a consistent member of the Protestant Episcopal Church, and he carefully trained his children to the reverence and love he had for its liturgy. For many years he was a leading member of Episcopal Conventions, and he made himself greatly useful in them. He was more than a Church member and a Church officer. He carried his religion into his daily life. It was a controlling power in his business, in the formation of his judgments, and in his intercourse with others. It was the basis of his fidelity to his clients, and of his unwillingness to do injustice to opponents. It led to the courtesy of his demeanor, and to his habitual candor. It contributed also to his personal enjoyments. He found great satisfaction in the study of religious books, especially those relating to doctrinal theology. "He loved to bring his reason to the support of his faith, and he delighted in the most cogent arguments in support of Christianity." His mind was at all times a reverent one. He discountenanced, systematically, in

Digitized by Google

his household, all conversation and every allusion that looked like irreverence on sacred subjects. More than once he brought the fine powers of his mind to the elucidation of Gospel narrative, and on one occasion he charmed his family and near friends by an essay written in his leisure moments, in support of his own view of a much debated religious question. There dwelt within him habitually a serious conviction of personal responsibility, that led to a high estimate of the value of time, and he was rigid in his self-examination. At one time, near the close of his life, when speaking of his debility, he said, "but I do not think that I have gone back, and I am very thankful for it, because a single step backward would, I think, have finished my *sum* and it must have been shown as it stood on the *slate*, right or wrong, to the Great Master. I hope that what is wrong in the *sum* may prove to be written on *slate*, that Mercy may pass her soft and gentle hand over it. But there is something which no touch will remove, because it is not *there*—THE GOOD I HAVE NOT DONE."

His faith was a support and consolation to him in the times of his great sorrow. It gave him infinite comfort when his son Horace was removed by death. Indeed the strongest bond of union between the father and the son was, at all times, the assurance they felt of their common confidence and trust in the Triune God, and that trust was the father's anchor when the waves of sorrow went over him. It never failed him. His last days were illumined by a calm reliance upon

Digitized by Google

his Redeemer, and by a perfect willingness to meet the final summons whenever it might come. Doubtless he was found watching. The books which he read and actually studied during the months of June and July immediately preceding his death were "The Philosophy of Natural Theology," an Oxford Prize Essay, written by the Rev. William Jackson, in confutation of the scepticism of the present day, and "The Unseen Universe," or "physical speculations on a future state," both of them works of deep-toned piety, as well as of great research. They cannot be read without close attention, and intense thought.

I feel that I ought not to detain you longer, though very much of great interest remains unsaid. *After all*, Mr. Binney's powers and character are best illustrated by his life. That was singularly consistent and complete. It is safe to say that rarely if ever, has a man lived who had fewer apparent defects From whatever point of human view he was observed, no flaw or imperfection was visible. In every aspect, he was symmetrical, with no faculty undeveloped or distorted, with not even an excellence overgrown at the expense of any other—throughout both great and good.

Such was Mr. Binney. So during three generations he stood erect and conspicuous among his brethren of the bar, and in this community, a light and an ornament—a strong tower and a ground of trust,—a leader and a guide.

Digitized by Google

Stated Meeting, January 7th, 1876.

Present, 13 members.

Vice-President, Mr. FRALEY, in the Chair.

Letters of acknowledgment were received from the R. Observatory at Prague, Oct. 13, (92); Bavarian Academy, Nov. 1, (92, 93); Holland Society at Haarlem, Aug. (92); L. and P. Society at Liverpool, Dec. 8, (93, 94); Anthropological Institute of Great Britain, Dec. 15, (XV, ii, 93, 94); and the New York Lyceum of Natural History, Dec. 28th, (XV, ii, 94).

Letters of envoy were received from the C. P. Observatory at St. Petersburg; C. Bureau of Statistics, Stockholm, Sept. 20; Bavarian Academy, Munich, Nov. 1; Haarlem Society, Jan. 20; L. and P. Society, Liverpool, Dec. 3; and Board of Commissioners of the Second Geological Survey of Pennsylvania.

Donations for the Library were received from the Bureau of Statistics at Stockholm; International Congress of Geography of 1875, at Paris; Prague Observatory; Geographical Society and Geological Institute at Vienna; Imperial Academy and Geological Society at Berlin; Zoological Gardens at Frankfort; Holland Society at Haarlem; Dr. Jos. B. Davis; R. Institute of Lombardy; Venetian Institute; Geological Committee at Florence; Academia dei Lincei, and Pontifical Academy at Rome; Observatory at Naples; Anthropological and Geographical Societies at Paris; Annales des Mines; Nouvelles Météorologiques; Revue Politique;

Digitized by Google

M. L. Hugo; Physical Society at Bordeaux; Astronomical, Chemical and Zoological Societies at London; Nature; Gen. Sabine; Silliman's Journal; Prof. Frederick Prime, Jr.; American Chemist; Penn Monthly; Journal of Pharmacy; Geological Survey of Pennsylvania; U. S. Department of the Interior, and Mexican Geographical and Statistical Society.

A set of photographs of ornaments on the Public Buildings were presented by Mr. McArthur.

The Committee on Dr. Valentini's paper reported progress and was continued.

The death of Dr. Wm. Böckh, at Christiania in Norway, Dec. 10, 1875, was announced by letter.

Prof. Houston communicated his views regarding the so-called "new force" claimed to have been discovered by Prof. Eddison of Newark, N. J.

The report of the judges and clerks of the annual election was read in its usual form, announcing as the officers of the ensuing year:—

President,

George B. Wood.

Vice Presidents,

John C. Cresson, Isaac Lea, Frederick Fraley.

Secretaries,

E. Otis Kendall, John L. LeConte, Pliny E. Chase, J. P. Lesley.

Curators,

Joseph Carson, Hector Tyndale, C. M. Cresson.

Treasurer,

J. Sergeant Price.

Digitized by Google

Councilors to serve for three years,

Alfred L. Elwyn, Benj. H. Coates, Benj. V. Marsh,
Geo. H. Horn.

Mr. Lesley was nominated Librarian.

Pending nomination No. 791 and new nomination No. 792 were read.

Mr. Price reported for the Committee on the Eulogium of the Hon. Horace Binney, that it was acceptably delivered on the evening appointed, and that the MSS. was already in the printer's hands.

On motion, the subject of the present condition of the space alongside of the Hall was referred to the Hall Committee for speedy action.

And the meeting was adjourned.

Digitized by Google

On the Progress of the Museum and Palæontological Work of the Second Geological Survey of Pennsylvania, for the year 1875.

By Charles E. Hall.

(*Read before the American Philosophical Society, January* 15, 1876.)

The principal collections received from the Assistants and their parties have generally been to demonstrate the sections made by them in their particular districts.

The following collections of fossils have been made:

A series of specimens representing a section from Bellefonte, Centre County, to the Allegheny Mountain, including specimens from the Limestone of II up to the Coal Measures. Number of specimens 165. A collection of bituminous and cannel coals, also cokes. By Mr. F. Platt.

A series of specimens representing the horizons of the Mountain and Oil sands with their included measures and fossils from Venango, Warren, Foster and Crawford Counties. By Mr. J. F. Carll.

Specimens from Mifflin County, representing the Logan and Lewistown Sections;—from Graham's, Snyder's and McKees' fossil-ore openings;—McVeytown Section, including Ross's, McCoy's and Dull and Brady's Ore Banks (Marcellus hematite);—Mt. Union Section. Number of specimens 747. By J. H. Dewees.

Specimens from the South Mountain district, including some fossils. By Prof. Fredk. Prime, Jr.

Specimens of sandstone with Scolithus linearis, from Franklin County. By Prof. P. Frazer, Jr.

Collection of Coal Plants from Washington and Green Counties. By Prof. Stevenson and J. C. White.

Collection of Fossils from the Chemung and Catskill, with section through a portion of the Chemung, Tioga County. By A. Sherwood.

Collection of Fossils from the Hamilton Group at Marshall's Falls, Monroe County. By H. Martyn Chance.

Specimens representing a section from the Limestone of II at Orbisonia to the Coal Measures of Broadtop Mountain, Huntingdon County. Number of specimens 350. By C. E. Billin and C. A. Ashburner.

Besides these there have been special palæontological collections made at the following localities during the past summer:

From the Carboniferous in Westmoreland County, and in Washington and Greene Counties.

From the Catskill, in Tioga County.

From the Chemung group, from eight localities in Tioga County.

From the Hamilton group at Marshall's Falls and vicinity, in Monroe

Digitized by Google

County; at Orbisonia and vicinity in Huntingdon County; and at Bell's Mills in Blair County.

From the Oriskany Sandstone at Orbisonia and vicinity.

From the Lower Helderberg, at Orbisonia and vicinity, and at Mansing's Quarry, Carbon County.

From the Clinton Group, at McKee's ore bank, Mifflin County; at Matilda Furnace, Mifflin County: at Orbisonia, in Huntingdon County; at Bell's Mills, in Blair County; and at Hollidaysburg, in Blair County.

From the Oneida Conglomerate at Port Clinton, Schuylkill County.

From the Utica Slate and Hudson River group; at Bellefonte, Centre County; near Henrietta, Bedford County; at Henrietta, Blair County.

From the Trenton Limestone; in the Kischicoquillas Valley, Mifflin County; at Bellefonte, in Centre County.

From the horizon below the Trenton; at Reedsville, Kischicoquillas Valley, Mifflin County; from near Bellefonte, Centre County; and from near Martinsburg, Blair County.

The following list of genera and species shows the result of the season's work. I have also included those mentioned by Prof. H. D. Rogers in the First Survey, many of which I have been able to recognize in our limited collection. All the species, except those of the Chemung have been collected during the past summer.

UPPER CHEMUNG (*and Waverly*).

Actinocrinus,
Aristozoa,
Bellerophon,
Carina hamiltonæ,
Cyrtina hamiltonensis,
Cystids,
Discina newberryi,
Dithyrocaris,
Euripterus,
Fenestella,
Lepidechinus,
Lingula delia,
Modiomorpha alta.
Orthoceras,
Platyceras,
"
Productella boydii
" costatula,
" striatula,
Rhynconella contracta,
Spirifer alta,
" disjuncta,
Streptorynchus chemungensis.

These specimens are from Warren and Venango Counties, from J. F. Carll, and F. A. Randall.

CHEMUNG. (*Vergent, VIII.*)

Athyris angelica,
" polita,
Atrypa spinosa,
Discina newberryi,
Gramnysia,
Productella lachrymosa var. stigmata,
" striatula,
Rhynconella orbicularis,
Spirifer disjuncta,*
Streptorynchus chemungensis,*

* Those marked * are mentioned by Rogers.

Digitized by Google

Modiomorpha
Orthis impressa,
Productella boydii,
Strophodonta cayuta,
" concava,
" perplana,

The above are from Tioga County.

HAMILTON GROUP. (*Cadent, VIII.*)

Aviculopecten princeps,
Athyris spiriferoides,*
Atrypa reticularis,
Ambocœlia umbonata,
Bellerophon,
Chonetes mucronatus,
" coronata,
Cryptonella planirostra,
Cimitaria recurva,
Discina grandis,
" newberryi,
Dalmania,
Fenestella,*
Gramnysia,
Heliophyllum halli,
Modiolopsis modiomorpha,
Lingula ligea,
Phacops bufo,*
Rensselæria? johanni,
Rynconella dotis,
Spirifer fimbricata,
" granulifera,*
" medialis,*
" mucronatus,*
" sculptilis,
Strophodonta concava,
" rhomboidalis,
Trepidoleptus carinatus,
Tentaculites.

All the above are from Marshall's Falls, Monroe County, Pa.

Rogers, p. 827, gives the following, also:

Atrypa aspera,
Spirifer congesta,.
Strophodonta perplana,
Strophodonta demissa,
Trematospira hirsuta,

ORISKANY SANDSTONE. (*Meridian, VIII.*)

Cyrtoceras expansus,
Dalmania micrurus,
Etonia peculiaris,
Megambonia lamellosa,
Orthis hipparionyx,*
Platyceras ventricosa,
Pterinea texilis,
Rensselæria marylandica,
" ovalis,
" ovoides,*
Spirifer arenosus,*
" arrectus.

All these are from the vicinity of Orbisonia.

LOWER HELDERBERG. (*Pre-Meridian, VI.*)

Acevalaria,
Alveolites minima,
Alveolites,
Artylospongia inornata,
Merista lævis,*
Orthis oblata,
Pentamerus galeatus,*
Rhynconella formosa,

* Those marked * are mentioned by Rogers.

Digitized by Google

Artylospongia,	Stromatopora,
Atrypa reticularis,	"
Aulopora,	Trematospira formosa,
Conophyllum,	Zaphrentis.
Merista arcuata,	

All the above are from Aughwick Valley, near Orbisonia.

Rogers, p. 825, gives the following, also:

Etonia peculiaris,	Spirifer macropleurus,
Platyostoma,	" sulcatus,
Rhynconella nobilis,	Strophodonta punctulifera.

NIAGARA, WATERLIME, AND ONONDAGA, OR SALINA. (*Scalent, VI.*)

Rogers, p 824, gives the following:

Beyrichia pennsylvanica,	Tentaculites ornatus.
Leperditia alta,	

CLINTON GROUP. (*Surgent, V.*)

Atrypa reticularis,*................	Ferguson and Aughwick valley.
Beyrichia lata,......................	" " " "
Buthotrepis gracilis,*...............	" " " "
Dalmania limulurus,................	" " " "
Homalonotus delphinocephalus,.....	" " " "
Illænus barrienis,...................	Ferguson valley, Mifflin county.
Merista intermedia,*................	Bell's Mills, Blair county.
Modiolopsis subcarinatus,...........	Ferguson valley.
Orbicula,............................	Bell's Mills.
Orthis elegantula,*.................	Ferguson and Aughwick valley.
Orthonota curta,...................	" valley.
Platyostoma niagarensis,............	" and Aughwick valley.
Pterinea emacerata,................	" " " "
Pterinea rhomboidea,...............	" valley
Rhynconella neglecta,..............	" and Aughwick valley
" robusta,...............	" valley.
Spirifer radiatus,...................	Bell's Mills.
Strophomena rhomboidalis,*........	Ferguson and Aughwick valley.
" subplána,*............	" valley.
Strophodonta prisca,...............	" "

ONEIDA CONGLOMERATE AND MEDINA SANDSTONE. (*Levant, IV.*)

Arthrophycus harlani.*	Mifflin and Schuylkill Counties.

Rogers, p. 822, gives the following, also:

Bucania trilobatus,	Lingula cuneata.

* Those marked * are mentioned by Rogers.

Digitized by Google

UTICA SLATE AND HUDSON RIVER. (*Matinal, III.*)

Chætetes lycoperdon,	Canoe valley.
Glyptocrinus decadactylus,*	" "
Graptolithus,	" "
Strophomena,	" "
Triarthrus beckii,*	Nittany valley.

Rogers, p. 818, gives the following, also:

Agnostus lobatus,
Ambonychia bellistriata,
" radiata,
Avicula insueta,
Bellerophon bilobatus,
Conularia trentonensis,
Cyrtolites ornatus,
Endoceras proteiforme,
Graptolithus pristis,
Heterocrinus,
Lingula curta,
Lingula quadrata,
Modiolopsis modiolaris,
Murchisonia gracilis,
Orbicula,
Ormoceras crebriceptum,
Orthis lynx,
Orthoceras vertebrale,
Pleurotomaria bilix,
" subconica,
Rhynconella increbescens,
Stictopora acuta.

TRENTON LIMESTONE. (*Matinal, II.*)

Calymene senaria, ...	Nittany valley.
Chætetes lycoperdon,*	" and Kischicoquillas valley, and Northampton county.
Crytoceras trentonensis, ...	Nittany valley.
Dalmania gigas,*	" "
Eschapora recta, ...	Kischicoquillas valley.
Leptæna sericea,*	" and Nittany valley.
Lingula riciniformis, ...	Nittany valley.
Orthis testudinaria,*	Nittany and Kischicoquillas valley.
" tricinaria, ...	" valley.
" pectinella,*	Northampton county.
Stictopora elegantula, ...	Kischicoquillas valley.
Strophomena alternata,*	Nittany and Kischicoquillas valley.
" deltoidea, ...	Nittany valley.
Trinucleus concentricus,*	" and Kischicoquillas valley.

BLACK RIVER LIMESTONE. (*Matinal, II.*)

Chætetes lycoperdon, ...	Canoe valley.
Gonioceras anceps, ...	" "
Murchisonia angustata, ...	Kischicoquillas valley.

* Those marked * are mentioned by Rogers.

Digitized by Google

Orthoceras multicameratum,*	Canoe valley.
Pleurotomoria umbilicata,*	" "

Rogers, (p. 817) mentions the following, not as yet observed :

Euomphalus ungulatus,	Ophileta levata,
Maclurea matutina,	Pleurotomaria nucleolata,
" magna,	Pleurotomaria turgida,
Murchisonia bicincta,	Retapora staminea,
Leperditia ovata,	" striata,
Orthoceras tenuifillum,	Rhynconella plicifera.

CHAZY LIMESTONE. (*Matinal, II.*)

Asaphus canalis,*	Kischicoquillas valley.
" marginalis,	" "
Orthis costalis,	" "
Orthoceras,	" "
Strophemena incrassata,*	" "

LOWER LIMESTONES. CALCIFEROUS. (*Auroral, II.*)

Asaphus,	Nittany valley.
Euomphalus,	Canoe valley.
Illænus,	Nittany valley.

POTSDAM SANDSTONE. (*Primal, I.*)

Scolithus linearis,	Lehigh and Franklin counties.

In the above list no mention is made of the organic animal remains of the Coal Measures, no collections in these having been as yet systematically made. Those observed by Prof. J. J. Stevenson in Washington and Greene Counties will be recorded in his forthcoming report of 1875.

An important collection recently sent in by Mr. Carll has not yet been sufficiently studied to be included in the present notice.

* Those marked * are mentioned by Rogers.

Digitized by Google

Contributions to the Physical Geography of the United States, by Charles Allen, Assistant in charge of the Collection and Collation of Railroad and other Levels for the Second Geological Survey of Pennsylvania.

BY J. P. LESLEY.

(*Read before the American Philosophical Society, January* 15, 1876.)

In presenting to the attention of the members Mr. Allen's list of Pennsylvania levels, I have only to say that the progress of physical geography in the United States has been so rapid, of late years, as to attract the attention of the Scientific world at home and abroad, and that its connection with the progress of geological science is so intimate, that working geologists hail with lively pleasure the publication of all hypsometrical records of a genuine kind, whether old or new. For want of government bureaus of statistics the greater part of such records have been irrecoverably lost. Of the tentative work of our railway, canal, slackwater and turnpike companies, done between 1830 and 1860, scarcely a trace remains; although, if its records could be recovered and printed, they would furnish copy for hundreds of volumes. Since 1860 the destruction has not been so complete, but has been nevertheless very great. There are recent important surveys of which no records can be found, even in the offices of the companies for whom they were made.

This important subject has received well-deserved attention at the hands of the chiefs of the United States Exploring Expeditions, who are mapping the interior of the Continent. But some efficient organization is required for the preservation and publication of levels in the States lying between the Atlantic and the Mississippi.

The State Geologists of Ohio and North Carolina, also, have published valuable hypsometric tables.

Digitized by Google

A beginning has now been made in Pennsylvania; and the following pages contain the records of the height above some assumed datum, reduced to tide level, of all stations on railways in the State, and in its immediate vicinity.

These records have mostly been obtained by personal examination of the profiles preserved at the offices; and in some cases, by letter, from superintendents and engineers. The greatest interest in the Collection has been manifested by members of the profession of Civil Engineering to whom application has been made; and in some instances, where records were wanting, new levelings have been ordered and the results transmitted.

Short headings are prefixed to the records, stating place, date and authority; and foot notes appended to them, stating difficulties of adjustment, incongruities, or doubts.

That a work of this nature should have the advantage of first publication in the transactions of the oldest Scientific Society of America, whose first President was Benjamin Franklin, and whose hall stands side by side with the ancient Capitol of the United States, is my reason for asking that this first systematic attempt on a large scale to render permanent and useful to all engineers and surveyors the scattered and perishable records of heights above sea-level of several thousand points in our valleys and on our mountains should be accepted by the Society.

It must be understood, however, that these lists require thorough re-examination and correction before they can be adopted as constants of science for the future. There are considerable difficulties yet to be encountered by such as undertake to harmonise the data of our railway surveys. Indeed, considering the imperfect way in which such surveys are necessarily made,—the accumulation of errors of instrumentation and personal equation along every long spirit-level line,—the uncertainty even of the tide-level datum at every head of tide,—the frequent lack of notes stating whether railway levels cross each other on grade, or not,—and the not uncommon fact that, after location-surveys have

Digitized by Google

been made, the road-beds have been tempered up, or down, to suit convenience, and no record of the fact been kept, except in the memory of some division engineer no longer in the employ of the Company,—it is surprising that the errors of terminal or crossing adjustment are so few and small. But to render the record perfect all such errors, however few and small, must be eliminated; and this can only be accomplished by a zealous interest taken in the subject by resident engineers; who are therefore earnestly requested to co-operate to this end.

Geologists are dependent for the goodness of their field-work on accurate base-line levels. And it is to be hoped that a complete exhibition of the surface contour of Pennsylvania will sooner or later be obtained from a collation of the thousands of transit-lines and barometer-lines now in progress in all the districts occupied by the Assistant Geologists of the Survey. All their lines of levels are, however, based on the railroad records, and the publication of these in a corrected form is a necessary preliminary step.

If movements are still taking place in the crust of the earth,—and the frequent occurrence of slight earthquake shocks, in all the States of the Union, seems to speak in favor of the supposition,—physical philosophers are peculiarly interested in an early establishment of a universal hypsometrical record. From this point of view, also, it would seem especially germain to the origin and history of the American Philosophical Society to initiate such a record.

The net-work of Surveys which cover Pennsylvania may be divided into nine systems:

1. The Pennsylvania Central east and west system, from Trenton through Philadelphia, Harrisburg, Altoona, Pittsburgh, to Steubenville, and Youngstown, in Ohio; with numerous longer or shorter side branches.

2. The Reading Railroad northwest and southeast system, with many short branches in the Schuylkill Anthracite Field, and through the country in front of it between the Delaware and Susquehanna Rivers. It has been extended also to the

Digitized by Google

waters of the Upper Susquehanna, and will penetrate into New York State.

3. The North Pennsylvania north and south system, with numerous branches in the Lehigh and Wilkesbarre Anthracite Fields, in connection with the two Lehigh Valley Railroads, extending into the State of New York.

4. The Northern Central north and south system, extending from Baltimore, in Maryland, to Elmira, in New York, with several short branches.

5. The Philadelphia and Erie northwest system, with important branches crossing to the Alleghany River, and into the State of New York.

6. The Alleghany River north and south system, from Pittsburgh to the Oil Region, and Buffalo in New York.

7. The Baltimore and Ohio system, with its Connellsville branch to Pittsburgh, and its short coal and coke branch.

8. The Beaver River system, north and south, along the western margin of the State.

9. The Philadelphia, Wilmington and Baltimore southwest system.

The following tables are arranged in the above order, and will explain themselves:

I. The Pennsylvania R. R. System.

I. Pennsylvania Railroad.

NOTE.—The elevations at the various stations, on the Pennsylvania Railroad, were copied from the Engineers' notes, by permission of Mr. W. H. Wilson, its Consulting Engineer.

The datum, or base of levels, is ordinary high-water in Schuylkill River. This datum, according to Mr. James T. Gardener's determination, is 6.913 feet* above mean surface of the Atlantic Ocean. *These 7 feet are added in the second column.* Decimal parts of a foot do not occur in these lists. When below .5 they have been omitted; when more than .5 a whole number has been substituted.

* Permanent U. S. Coast Survey granite bench at Gloucester Ferry, N. J., opposite Philadelphia, is 8.10 above Mean Tide Raritan Bay, or Mean Ocean level. Mean Tide Delaware River = 8.10 — 4.751 = 3.349. Philadelphia City Surveyor's datum: 8.10 — 0.632 = 8.732. Pennsylvania R. R. Engineer's datum: 8.10 — 1.819 High tide, 6.913.

Digitized by Google

Pennsylvania R. R. Main Line.

STATIONS.	High Tide, Philad'a.	Above mean level Atlantic Ocean.	
Philadelphia, Market Street........	25	32	
West Philadelphia................	27	34	
Powelton Avenue................	38	45	
Fairmount Bridge	44	51	
Mantua..........................	94	101	
Belmont Avenue................	103	110	
Hestonville	136	143	
City Avenue.....................	214	221	
Merion	240	247	
Elm	278	285	
Wynnewood	308	315	
Ardmore........................	352	359	
Bryn Mawr	409	416	
Rosemont	388	395	
Villa Nova.....................	423	430	
Union	423	430	
Radnor	402	409	
Edgewood Avenue..............	394	401	
Wayne	398	405	
Reeseville	488	495	
Paoli............................	527	534	
Green Tree......................	536	543	
Malvern.........................	539	546	
Fraser	483	490	
Glenlock........................	446	453	
Ship Bridge *....................	404	411	
Walkertown.....................	381	388	
E. B. & W. R. R. See Tab. II....	248	255	
Downingtown	259	266	
Gallaghersville..................	291	298	
Thorndale......................	306	313	
Cain.............................	352	359	
Coatesville (W.&R.R.R.) Tab. LVI.	373	380	
Midway.........................	387	394	
Pomeroy. P. & D. R. R. Tab. III.	476	483	
Chandlers	482	489	
Parkesburg	530	537	
Summit †.......................	551	558	
Penningtonville.................	493	500	
Christiana......................	484	491	
Summit ‡.......................	566	573	
Gap	552	559	
Kinzers	461	468	
Spindlers	397	404	
Leamen Place	375	382	
Gordonville	378	385	
Fairview	378	385	
Bird in Hand....................	352	359	

* Intersection of Waynesburg Branch.
† West of Parkesburg.
‡ East of Gap Station.

Digitized by Google

STATIONS.		High Tide, Philad'a.	Mean Tide Atlantic Ocean.
Lancaster ‡		352	359
Dillerville Junction ‖	Columbia Line.	352	359
Rohrerstown §	Columbia Line.	345	352
Mountville	Columbia Line.	397	404
Columbia	Columbia Line.	244	251
Chiquies	Columbia Line.	248	255
Marietta	Columbia Line.	253	260
Shocks Mill	Columbia Line.	262	269
Bainbridge	Columbia Line.	264	271
Collins	Columbia Line.	278	285
Middletown Junction (*a*).	Columbia Line.	307	314
Landisv'e R.&C.R.R. (*b*). Tab. LVII		398	405
Salunga		396	403
Chiquies Bridge		344	351
Mount Joy (*c*)		359	366
Springville		383	390
Reams		432	439
Tunnel		472	479
Elizabethtown		450	457
Conewago		422	429
Middletown		307	314
Highspire		293	300
Harrisburg *		313	320
Susquehanna		335	342
Susquehanna Bridge		343	350
Marysville		343	350
N. C. R. R. Crossing † Tab.		342	349
Duncannon		349	356
Aqueduct		370	377
Bailys		380	387
Newport		388	395
Millerstown		401	408
Thompsontown		412	419
Tuscarora ¶		422	429
Mexico		426	433
Perryville		434	441
Mifflin		434	441
Black Log		455	462
Bixlers		475	482
Lewistown		491	498
M. & C. C. R. R. Crossing‖ Tab. V.		492	499
Granville		491	498

‡ Bench Mark on Stone Wall, Lancaster Locomotive Works, 339.

‖ Junction of Columbia Branch, at Dillerville.

§ On Columbia Branch.

(*a*) Junction of Columbia Branch, at Middletown.

(*b*) Reading and Columbia R. R. Crossing, at Landisville.

(*c*) East side of R. R. Hotel.

* West line of depot 313.91. Curb stone at lamp post U. S. Hotel 313.54. West line of Lebanon Valley Depot 315.5. West line of State street 319.2.

† Northern Central R. R. Crossing.

¶ Bench Mark on top of Stone foundation west corner of Water Station 424.44.

‖ Junction at Mifflin and Centre County R. R.

Digitized by Google

STATIONS.	High Tide, Philad'a.	Mean Tide Atlantic Ocean.
Anderson's	493	500
Anderson's. Water Station	492	499
McVeytown	515	522
Manayunk	512	519
Vineyard	541	548
Newton Hamilton	592	599
Mount Union. § E. B. T. Tab. VII.	590	597
Jackstown	588	595
Mapleton	586	593
Mill Creek	597	604
Huntingdon.* H.& B.T.Tab.VIII.	615	622
Warrior Ridge	670	677
Petersburg	671	678
Sherman's Bridge †	692	699
Barre Forge	717	724
Tunnel ‡	754	761
Spruce Creek	770	777
Union Furnace	792	799
Birmingham	859	866
Tyrone Water Station	889	896
Tyrone R.R. Tables XIII.XIV.XV.	900	907
Tipton	983	990
Fostoria	1022	1029
Bells Mills R. R. Table XVIII	1053	1060
Elizabeth Furnace	1072	1079
Blair Furnace	1107	1114
Altoona ‖ R.R.Tables XIX.-XXIII	1171	1178
Kittanning	1587	1594
Murdocks	1619	1626
Alligrippus	1913	1920
Bennington Furnace	2031	2038
Tunnel ¶	2119	2126
Gallitzin	2154	2161
Cresson (*a*) E.&C.R.R.Tab.XXIV.	2010	2017
Lillys	1880	1887
Portage	1668	1675
Wilmore	1550	1557
Summit (*b*)	1562	1569
Summerhill	1550	1557
South Fork	1477	1485
Viaduct (*c*)	1449	1456

§ Junction of East Broad Top R. R. (narrow guage).

* West line of ticket office, crossing south track west to Huntingdon & Broad Top R. 613.9.

† Bench Mark on west end of bridge.

‡ West end of Spruce Creek Tunnel.

‖ West line of ticket office 1171. B. M. (Bench Mark) south-west corner, top step front door of ticket office 1174.

¶ B. M. at east end of Tunnel, on rough part of first course of stone above foundation.

(*a*) Switch to Ebensburgh and Cresson R. R. 2021.

(*b*) Pringles point.

(*c*) Bench Mark on N. W. corner west end of coping.

Digitized by Google

STATIONS.	High Tide, Philad'a.	Mean Tide Atlantic Ocean.	
Mineral Point	1407	1414	
Conemaugh	1218	1225	
Johnstown	1177	1184	
Sandy Hollow	1136	1143	
Conemaugh Furnace	1128	1135	
Nineveh	1134	1141	
New Florence	1069	1076	
Houstons	1049	1056	
Lockport	1047	1054	
Bolivar	1026	1033	
Blairsville Junction * Tab. XXV.	1106	1113	
Hillside	1122	1129	
Millwood	1148	1155	
Derry	1165	1172	
Lindorff's Summit	1178	1185	
St. Clair } Lig. R.R. Tab. XXIX.	1085	1092	
Latrobe } Lig. R.R. Tab. XXIX.	999	1006	
Beatty's	1066	1073	
Kearney's †	1041	1048	
Shanghai	1166	1173	
Carr's Tunnel ‡	1201	1208	
George's	1199	1206	
Greensburg‖S. W. P. RR. Tab. XXX.	1084	1091	
McGrau's Tunnel §	1156	1163	
Radebaughs	1143	1150	
Grapeville	1052	1059	
Penn	967	974	
Manor	935	942	
Shafton	893	900	
Irwin's. Y. R. R. Table XXXI.	877	884	
Larimer's	859	866	
Carpenter's	847	854	
Stewart's	784	791	
Wall's	744	751	
Springhill	742	749	
Turtle Creek	743	750	
Oak Hill	743	750	
Brinton's	750	757	
Braddock's	821	828	
Copeland	846	853	
Hawkins'	876	883	
Swiss Vale	915	922	
Edgewood	916	923	
Wilkinsburg	916	923	
Brushton	915	922	

* Intersection of Blairsville and Indiana Branch of Pa. R. R. with main line.

† Rogers' Summit 1201.8.

‡ East face of Tunnel.

‖ B. M. east face of Greensburg Tunnel on top of rough part of second course from bottom 'R' 1079.52.

§ West face of tunnel.

Digitized by Google

STATIONS.	High Tide, Philad'a.	Mean Tide Atlantic Ocean.	
Homewood	916	923	
Torrens	913	920	
East Liberty	911	918	
Roups'	875	882	
Shadyside	859	866	
Millvale	826	833	
Lawrenceville	773	780	
Pittsburgh *	738	745	

II. East Brandywine Railroad.

NOTE.—The levels on the East Brandywine and Waynesburg R. R. were furnished by Mr. W. H. Wilson, Consulting Engineer of the Pennsylvania R.R. The datum, or base of levels is ordinary high water in Schuylkill River, Philadelphia. Therefore 7 *feet are added in the second column to reduce to mean tide in the Atlantic Ocean.*

STATIONS.	High Tide, Philad'a.	Ocean Level.	
Downingtown Terminus. † Table I.	249	256	
Shelmeirs	239	246	
Dowlin's Forge	271	278	
Dorlan's	273	280	
Reed's Road	302	309	
Brooklyn	329	336	
Cornog's	354	361	
Springton	398	405	
Moorestown	436	443	
Barnestown	479	486	
Lewis Mills	535	542	
Cupola	556	563	
Forrest	564	571	
Dampman's	624	631	
W. & R. R. R. ‡ Table LVI.	666?	673?	
Buchanan's	665	672	
Lancaster Pike	689	696	
Waynesburg	721?	728?	
End of Track	734	741	

* West face of Union Passenger Depot, east side of Wayne Station 734.5. East side of Irwin street 729.7. East side of Duquesne street depot 725.4. Bench Mark at foot of lamp post south side of Liberty street, intersection with Water street 721.27.

Bench Mark on south side of base ring, of fire plug, north side of Penn street, intersection with Water street, 719.

† Junction with north track of the Pa. R. R. near Downingtown.

‡ Crossing Wilmington and Reading R. R.

Digitized by Google

III. Pennsylvania and Delaware R. R.

NOTE.—The elevations on the Pennsylvania and Delaware Railroad were obtained in the office of Mr. George W. Leuffer, C. E., of Philadelphia.

At Pomeroy Station, 43 miles of Philadelphia, this road joins the Pennsylvania R. R. Mr. Leuffer makes this point 472.9; Mr. Wilson 476.039. To Mr. Leuffer's levels in the first column are therefore added 3 feet to accord with the P. R. R. list, and an additional 7 feet to reduce to mean Atlantic tide level.

STATIONS.		High Tide, Philad'a.	Ocean Level.	
Pomorey Junction *	Table I.	472.9	483	
Doe Run		364	374	
Pusey's Summit		460.	470	
Pennock's Summit		453	463	
Avondale **	Table	271.6	281.6	
Newark †		108	118	
Delaware R. R. Crossing ‡		76.2	86.2	
Delaware City	§	6.	16	

IV. York Branch P. R. R.

The levels on the York Branch of the Pennsylvania R. R. were copied from the profile in the office of the P. R. R. at Philadelphia.

In accordance with instructions of Mr. W. H. Wilson, 3′ was added to each elevation, as shown on the profile, in order to agree with the level of Columbia according to Pa. R. R.; and also 7 feet to reduce to mean Ocean level.

STATIONS.		High Tide, Philad'a.	Ocean Level.	
Columbia §	Table I.	241.3	251.3	
Wrightsville		247.5	257.5	
Creitz Creek ‖		263.	273.	
Hellam		336	346	
Heistand's		327.2	337.2	
York (N. Central R. R.)	Tab.	371.7	381.7	

* Junction with Pennsylvania R. R. at Pomeroy Station, 43 (42.2?) miles west of Philadelphia.

** Crossing the Philadelphia and Baltimore Central R. R.

† Crossing of the Delaware Railway Line.

‡ Crossing of the Philadelphia, Wilmington and Baltimore R. R.

§ Junction with the Columbia Branch of the Pa. R. R.

‖ Bench mark on east end of coping girder of bridge No. 3, over road and Creitz Creek.

Digitized by Google

V. *Mifflin and Centre Co. R. R.*

The levels of the Mifflin and Centre Co. Railroad were copied from a profile in the office of the Pennsylvania R. R. Co., at Philadelphia, furnished by Mr. W. H. Wilson, Consulting Engineer, Pennsylvania R. R.

The datum is that of the Pennsylvania R. R., 7 *feet added*, to reduce to mean Atlantic level, in the second column.

STATIONS.	Above Tide.	Ocean Level.	
Lewistown Junction*............	492	499	
Logan..........................	527	534	
Yeagertown.....................	561	568	
Mann's.........................	673	680	
Reedsville.....................	695	702	
Honey Creek....................	807	814	
Nagney.........................	849	856	
Milroy†........................	987	994	

VI. *Sunbury and Lewistown R. R.*

NOTE.—No records of this road could be obtained.

VII. *East Broad Top Narrow Gauge R. R.*

The levels on the East Broad Top R. R. (3 foot gauge), were copied from a profile in the office of the Company, at Orbisonia, by permission of Mr. A. W. Sims, Superintendent.

The datum of the profile is an assumed elevation, and has been reduced to tide level by reference to the Pennsylvania R. R. grade at Mount Union, 590′, with 7′ added to reduce to mean Atlantic Ocean level.

STATIONS.	Assumed Datum.	Ocean Level.	
Mount Union Junction ‡.........	810.65	597	
Morrison's Summit..............	828	615	
Aughwick Creek.................	773.60	560	
Shirleysburg...................	784.94	572	
Douglas Summit.................	811.24	598	
McMullen's Summit..............	882.74	669	
Orbisonia......................	837.62	624	
Jordan's Summit................	922.22	709	
Scottsville....................	929.85	717	
Saltillo.......................	994.70	781	
Moreland's Summit..............	1326.90	1114	
Sidling Hill...................	1445.47	1232	
Cole's Station.................	1572.06	1359	
Cook's Mill....................	1741.28	1528	
Cook's Station.................	1754.24	1541	
Coal Openings..................	1978.10	1765	
Robertsdale....................	1998.70	1785	
End of Road §..................	2030.02	1817	

* With the Pennsylvania R. R. near the Lewistown Station. Table I.

† Terminus in the Kishicoquillis Valley. This survey has been extended through the Seven Mountains to Bellefonte.

‡ East Broad Top R. R. connects with Pennsylvania R. R. at Mount Union.

§ On the plateau of the Broad Top Mountain in Huntingdon County.

Digitized by Google

VIII. *Huntingdon and Broad Top R. R.*

The levels on the Huntingdon and Broad Top R. R. and its Branches, were furnished by Mr. John Fulton, General Mining Engineer of the Cambria Iron Works at Johnstown, Pa.

The datum is 0 at grade on the Pennsylvania R. R. at Huntingdon. To this 614' are added, + 7', to reduce all to mean Atlantic Ocean level.

This road has three coal branches up the three streams which drain the Broad Top Coal Region. It originally stopped at Everett; but has been continued to Bedford and Bridgeport under the name of the Bedford and Bridgeport Railroad. Table IX.

The elevations on the Bedford and Bridgeport R. R. were furnished by Mr. S. M. Prevost, Superintendent of the Bedford Division of the Pennsylvania R. R.

The datum 0 of this road was at grade of the Pennsylvania R. R at Huntingdon; which Mr Prevost called 610; while Mr. Wilson calls it 614. The difference of 4 feet has therefore, in the 2d column, been added to Mr. Prevost's figures, to make them agree with Mr. Wilson's figures, along the main line. The regular 7 feet addition has also been made in the second column to reduce to mean Atlantic Ocean level.

STATIONS.	Above Huntingdon.	Ocean Level.	
Huntingdon	000	621	
McConnellstown	56.2	677	
Pleasant Grove	127.2	748	
Marklesburg	167.6	789	
Coffee Run	250.6	872	
Rough and Ready	267.6	889	
Cove	300	921	
Fisher's Summit	253	874	
New Bridge	210.3	831	
Saxton (new depot)	228	849	
Riddlesburg	243.6	865	
Hopewell	277.3	898	
Piper's Run	326.3	947	
Brallier's Summit	487.3	1108	
Tatesville	475.3	1096	
Bloody Run Summit	613.3	1234	
Everett	497 3	1118	

IX. *Continued as the Bedford and Bridgeport R. R.*

Mount Dallas........(above tide)	1046	1053	
Cove Creek	1026	1033	
Lutzville	1038	1045	
Bedford	1055	1062	
Wolfsburg Summit	1111	1118	
Napier	1101	1108	
Mann's Choice	1129	1136	
Buffalo Summit	1349	1356	
Fossilville	1084	1091	
Bridgeport (*a*)	923	930	
Maryland State Line (*b*)	837	840	

(*a*) Not the Bridgeport of Clearfield County in Table XIV.

(*b*) Continued as Baltimore, Connellsville & Pittsburgh R. R. Branch of the Baltimore and Ohio R. R.

Digitized by Google

X. Shoup's Run Branch of H. & B. T. R. R.

Saxton (as above)...............	228	849	
Coalmont........................	488.8	1110	
Crawford........................	620.9	1242	
Old M. P........................	662 7	1284	
No. 3. Mine.....................	784.5	1405	
Barnet Mine.....................	767	1388	
Dudley Station..................	803.6	1425	
Blair's Mine....................	815.2	1436	
Moredale........................	1058.7	1680	
Water Station...................	1088	1709	
End of Track....................	1240.2	1861	

XI. Six Mile Run Branch of H. & B. T. R. R.

Riddlesburg (as above)..........	243.6	865	
" Coal Mine...........	340.9	962	
Coaldale........................	505.2	1126	
End of 3d Mile..................	573	1194	
End of 4th Mile.................	753	1374	
End of Track....................	795	1416	

XII. Sandy Run Branch of H. & B. T. R. R.

Hopewell (as above).............	277.3	898	
End of Track....................	404	1025	

XIII. Lewisburg, Centre and Spruce Creek R. R.

NOTE.—The levels on the Lewisburg Centre and Spruce Creek R. R. were furnished by Mr. George W. Leuffer, Chief Engineer. Mr. Leuffer says, "I will remark that many of the Stations have, as yet, not been located. The tide levels are based upon a level furnished by A. B. Starr, Esq., Engineer of P. & E. R. R., of a point in abutment of Chilesquaque Bridge (of P. & E. R. R.), and this agrees so closely with the level of tide, as stated in printed table of Pennsylvania R. R. Co., of Tyrone City, that I am inclined to rely upon the levels I now enclose."

The first column, then, gives the figures of Mr. Leuffer.

The second column has 7 feet added to Mr. Leuffer's figures, on the supposition that his datum is Pennsylvania R. R. datum of high water at the Schuylkill Bridge.

The third column has 8 feet added (in addition, = 15 feet in all) to agree with the final mean Atlantic Ocean level assigned to Tyrone, in the Pennsylvania R. R. list, No. I.

Digitized by Google

STATIONS.	Above Tide.*	Ocean Level.†	Ocean Level.‡	
P. & E. R.R. Junction (*a*)	447	454	462	
Lewisburg	451	458	466	
Biehl	503	510	518	
Vicksburg	514	521	529	
Mifflinburg	550	557	565	
Millmont	570	577	585	
Laurelton	592	599	607	
Tunnel (*b*)	944	951	959	
Fowler's	976	983	991	
Beaver Dam Tunnel	999	1006	1014	
Caburn (*c*)	1011	1018	1026	
Buchannon (*d*)	1044	1051	1059	
Duncan	1063	1070	1078	
Centre Hall	1257	1264	1272	
Summit (*e*)	1275	1282	1290	
Lemont (*f*)	987	994	1002	
Kelly (*g*)	1096	1103	1111	
Pinegrove	1221	1228	1236	
Shugarts	1116	1123	1131	
Lyon (Penna. Furnace)	1059	1066	1074	
Guyer (*h*)	1129	1136	1144	
Lowrie (*i*)	1094	1101	1109	
Miller (*j*)	1055	1062	1070	
Tyrone (*k*) ....(I)	892	899	907	

XIV. Tyrone and Clearfield R. R.

The elevations on the Tyrone and Clearfield R. R. were copied from a profile in the office of the Pennsylvania R. R. Co. in Philadelphia. The datum is a point 60′ below Tyrone, or as it appears on the profile elevation at Tyrone + 840′. Mr. W. H. Wilson is authority for adding 60′ to each elevation as shown on the profile.

In the second column seven feet are added to reduce to mean Atlantic Ocean Level.

* High tide, Schuylkill River, at Philadelphia?

† Calculated from the Lewisburg end.

‡ Adjusted to the Pennsylvania R. R. record at the Tyrone end.

(*a*) Junction with Philadelphia and Erie R. R.

(*b*) Through Paddy's Mountain.

(*c*) Forks of Penn's Creek.

(*d*) Mouth of Muddy Run.

(*e*) Summit of Penn's Valley, Head of Penn's Creek, and Head of Spring Creek, which enters Bald Eagle Creek after passing Bellefonte.

(*f*) End of Nittany Mountain.

(*g*) State Agricultural College.

(*h*) Half Moon Gap.

(*i*) At Warrior's Mark.

(*j*) Logan's Run.

(*k*) L. C. & Sp. Cr. R. R. here connects with the Pennsylvania R. R.

Digitized by Google

STATIONS.	Above Tide.	Ocean Level.	
Tyrone (Pennsylvania R. R.)..(I)	900	907	
Bald Eagle R. R. Junction........	977	984	
Vanscoyoc........................	1410	1417	
Gardners	1561	1568	
Mt. Pleasant.....................	1767	1774	
Emigh's Summit (*a*)............	2033	2040	
Sandy Ridge......................	1915	1922	
Powelton	1791	1798	
Osceola Branch R. R.............	1481	1488	
Dunbar...........................	1446	1453	
Moshannon Creek..................	1443	1450	
Steiner's Mill...................	1421	1428	
Philipsburg	1415	1422	
Blue Ball........................	1513	1520	
Shimmels.........................	1634	1641	
Wallacetown......................	1675	1682	
Turner's Summit..................	1735	1742	
Moravian Run.....................	1731	1738	
Ross' Summit.....................	1744	1751	
Smael's Summit...................	1709	1716	
Camp Hummel......................	1743	1750	
Bigler...........................	1655	1662	
Woodland.........................	1465	1472	
Roaring Run......................	1420	1427	
Leonard's Point..................	1299	1306	
Clearfield Creek.................	1133	1140	
Sharon's Run.....................	1105	1112	
Liberty Spring...................	1096	1103	
Clearfield.......................	1096	1103	
Goodfellow's Bridge..............	1103	1110	
Spackman's Bluff.................	1110	1117	
Susquehanna River................	1117	1124	
Hog Back.........................	1119	1126	
Hartshorn's Run..................	1125	1132	
Curwensville	1134	1141	
Anderson's Creek (*b*)...........	1144	1151	
Anderson's Creek (*c*)...........	1159	1166	
Bridgeport (*d*).................	1183	1190	

XV. Bald Eagle Valley R. R.

The elevations on the Bald Eagle Valley R. R. were copied from a profile in the office of the Pennsylvania R. R. Company, at Philadelphia. The datum is the same as that of the P. R. R.

In the second column seven feet are added to reduce to mean Atlantic Ocean Level.

(*a*) Allegheny Mountain Summit.
(*b*) First Crossing.
(*c*) Second Crossing.
(*d*) Not the Bridgeport of Bedford County in Table IX.

Digitized by Google

STATIONS.	Above Tide.	Ocean Level.	
Tyrone (as above)...............	900	907	
Spring Run.....................	888	895	
Dallas Street....................	921	928	
Sinking Run.....................	923	930	
Little B. E. Creek..............	940	947	
Bald Eagle......................	1051	1058	
L. B. E. Bridge.................	1065	1072	
Summit.........................	1103	1110	
Hannah........................	1050	1057	
Port Matilda (*a*)...............	1000	1007	
B. E. Creek Bridge.............	917	924	
Martha.........................	905	912	
Julian..........................	844	851	
Dick's Run.....................	794	801	
Unionville......................	775	782	
Snow Shoe R. R..........(XVI)	715	722	
Milesburg................(XVII)	693	700	
Bald Eagle Canal...............	664	671	
Holters'.......................	644	651	
Mount Eagle...................	655	662	
Bald Eagle Plank Road..........	658	665	
Howard........................	672	679	
Eagleville......................	628	635	
Beach Creek....................	607	614	
Mill Hall.......................	566	573	
Lock Haven Junction (*b*)........	548	555	

(*a*) Main Street.
(*b*) Junction with the Philadelphia and Erie R. R.

XVI. Bellefonte and Snow Shoe R. R.

The levels on the Bellefonte and Snow Shoe R. R. were furnished by Mr. I. L. Sommerville, Resident Engineer. The datum is that of the Pennsylvania R. R.

In the second column seven feet are added to reduce to mean Atlantic Ocean Level.

STATIONS.	Above Tide.	Ocean Level.	
Bellefonte................(XVII)	737	744	
Bald Eagle R. R. Junction..(XV)	715	722	
Gum Stump....................	1013	1020	
Summit (*a*)....................	1728	1735	
Beach Creek (*b*)................	1542	1549	
Beach Creek (*c*)................	1592	1599	
Snow Shoe.....................	1565	1572	
Middle Coal bed (*d*)............	1599	1606	

(*a*) Allegheny Mountain summit.
(*b*) *Level of water* in Beach Creek.
(*c*) Level of rail over the water.
(*d*) Middle coal bed at the Company's mines at Coal Hill.

Digitized by Google

XVII. Bellefonte Branch.

The levels on the Bellefonte Branch were copied from a profile in the office of the Pennsylvania R. R. Company, at Philadelphia, and have the datum of the P. R. R. to which are added seven feet to reduce to mean Atlantic Ocean Level, in the second column.

STATIONS.	Above Tide.	Ocean Level.	
Milesburg (*a*)..............(XV)	693	700	
B. E. V. Plank Road............	692	699	
Bellefonte................(XVI)	737	744	

XVIII. Bell's Gap (N. G.) R. R.

The elevations on the Bell's Gap Narrow Gauge R. R. (3 feet) were furnished by Mr. Jos. Ramsey, Jr., Superintendent.

The datum for the first column is 0 at Pennsylvania R. R. grade at Bell's Mills Station. To which are added 1053′ from Table I for the second column, and 7′ for the third column, to reduce to mean Atlantic Ocean Level.

STATIONS.	Bell's Mills.†	Corrected Tide.	Ocean Level.	
Bell's Mills Junction (I).	0	1053	1060	
Roots'..................	162	1215	1222	
Collier	581.6	1635	1642	
Point Lookout..........	854.6	1908	1915	
Lloyd's Junction (*a*)...	1107.4	2160	2167	
Lloyd's Station	1119.7	2173	2180	
Summit (*b*)............	1240.5	2294	2301	
Five Foot Coal (*c*)......	——	2116	2123	
Figart's	1048	2101	2108	
Vanscoyoc.............	935	1988	1995	
Crees Summit..........	797	1850	1857	
Hollen's (*d*)	582	1635	1642	
Three Foot Coal........	——	1667	1674	
Five Foot Coal	——	1727	1734	
Van Ormer's (*e*)........	352.3	1405	1412	
Three Foot Coal........	——	1475	1482	
Fallen Timber	362.	1415	1422	

(*a*) Junction with the Bald Eagle Valley R. R.

(*a*) Elevation of 5 foot coal bed at the mouth of gangway.

(*b*) Allegheny Mountain. Bench Mark, Summit of Mountain.

(*c*) Level of the 5 foot coal bed under the Bench Mark.

(*d*) Elevation at this point of the 3′ vein, 1667′; of the 5′ vein, 1727′.

(*e*) Elevation of *Water in Clearfield Creek.* The elevation of the 3′ vein here is 1475.

Digitized by Google

XIX. Hollidaysburg Branch P. R. R.

The levels on the Hollidaysburg Branch of the Pennsylvania R.R. were copied from a profile in the office of the P. R. R. Company, at Philadelphia.

The datum being mean high tide at the Schuylkill Bridge, seven feet are added in the second column to reduce the mean Atlantic Ocean Level.

STATIONS.	Above Tide.	Ocean Level.	
Altoona (Pennsylvania R. R.)..(I)	1172	1179	
Allegheny....................	1145	1152	
Eldorado	1086	1093	
Canon's	1059	1066	
Duncansville	983	990	
Hollidaysburg ....(XX)	946	953	
End of Line (*a*)	937	944	

(*a*) 3400′ beyond the station marked Hollidaysburg.

XX. Williamsburg Branch P. R. R.

The levels on the Williamsburg Branch, the Morrison's Cove Branch, the Bloomfield Branch, and the Springfield Branch of the Pennsylvania R. R., were copied from profiles in the office of the Pennsylvania R. R. Company, at Philadelphia.

The datum being mean high tide at the Schuylkill Bridge, seven feet are added to reduce to mean Atlantic Ocean Level.

The Williamsburg Branch R. R. has been substituted for the old State Canal, long since vacated, from Frankstown to Williamsburg, and shows the fall of the Juniata River.

STATIONS.	Above Tide.	Ocean Level.	
Graysport (*a*)..................	947	954	
Hollidaysburg ....(XIX)	935	942	
Brush Run....................	1026	1033	
Juniata River (*b*)	911	918	
Reese Station	896	903	
Clapper's Run	894	901	
Koofer's Run	886	893	
Juniata River (*c*)	886	893	
Pike Ponds	878	885	
Flowing Spring	874	881	
Springfield R.R. Junc.(*d*) (XXIII)	874	881	
Williamsburg	840	847	

(*a*) Bench Mark on step of ladies' waiting room, Graysport passenger station, 946.60.

(*b*) Frankstown or Main Branch of the Juniata River.

(*c*) Frankstown or Main Branch of the Juniata River.

(*d*) Springfield Branch.

Digitized by Google

XXI. *Morrison's Cove Branch P. R. R.*

STATIONS.	Above Tide.	Ocean Level.	
Hollidaysburg ....(XIX)	936	943	
Draw Bridge	935	942	
Juniata River (*e*)	935	942	
Reservoir	960	967	
Catfish	961	968	
Riddle's Lane	966	973	
Brooks Mill	999	1006	
McKee's Gap (*f*)	1029	1036	
Martha Furnace	1047	1054	
Hammond's	1126	1133	
Roaring Spring Junction.. (XXII)	1199	1206	
Erb's Summit	1347	1354	
Martinsburg Junction	1337	1344	
Martinsburg....................	1359	1366	
Henrietta Junction..............	1384	1391	
Mathew's Summit	1465	1472	
Nicodemus' Summit	1425	1432	
Clover Creek	1385	1392	
Henrietta Ore Bank	1402	1409	
End of Road (*g*)................	1415	1422	

XXII. *Bloomfield Branch P. R. R.*

STATIONS.	Above Tide.	Ocean Level.	
Roaring Spring (*h*)........(XXI)	1196	1203	
Trestle, No. 1	1214	1221	
Trestle, No. 2..................	1351	1358	
Bloomfield (*i*)	1453	1460	

XXIII. *Springfield Branch P. R. R.*

STATIONS.	Above Tide.	Ocean Level.	
Williamsburg R. R. Junc....(XX)	874	881	
Trestle, No. 1..................	961	968	
Goods..........................	999	1006	
Davis Summit	1372	1379	
8th Mile Post (*j*)...............	1367	1374	

(*e*) Frankstown Branch of the Juniata River.

(*f*) Through Dunning's Mountain.

(*g*) In Leather Cracker Cove, the southern end of Morrison's Cove.

(*h*) Junction of this branch with Morrison's Cove Branch R. R. XXI.

(*i*) Iron Mines and Furnaces.

(*j*) This R. R. ascends from the Juniata River to the Springfield Ore Mines in Canoe Valley, the northeast prolongation of Morrison's Cove.

Digitized by Google

XXIV. *Ebensburg and Cresson R. R.*

The elevations on the Ebensburg and Cresson Railroad were copied from a profile in the office of the Pennsylvania R. R. Company, in Philadelphia.

The datum is mean high water at the Schuylkill Bridge, to which are added seven feet to reduce to mean Atlantic Ocean Level.

STATIONS.	Above Tide.	Ocean Level.	
Cresson R. R. Junction (*a*)....(I)	2021	2028	
Plank Road Crossing............	2032	2039	
Lilly	2023	2030	
O'Harra.........................	2008	2015	
Durbin	1920	1927	
Sander's.........................	2012	2019	
Bradley's	2111	2118	
Dam (*b*).........................	1953	1960	

(*a*) The Junction with Pa. R. R. is not *at* Cresson 2010′ (2017′) but *near* Cresson 2021′ (2028).

(*b*) This is the last point on the profile where the elevation is given.

XXV. *Blairsville and Indiana Branch P. R. R.*

The elevations on the Blairsville and Indiana Branch of the Pennsylvania R. R. were taken from a profile in the office of the P. R. R. Company, at Philadelphia.

The datum is high tide Schuylkill River, at the Philadelphia Market Street Bridge. To this seven feet are added in the second column to reduce to mean Atlantic Ocean Level.

STATIONS.	Above Tide.	Ocean Level.	
R. R. Junction (*a*).............(I)	1104	1111	
Pennsylvania Canal	958	965	
R. R. Junction (*b*)...............	970	977	
Blairsville (*c*)	1004	1011	
Smith's Summit.................	1096	1103	
Wier's Run	963	970	
Black Lick	956	963	
Water Station	959	966	
Black Lick Bridge..............	1075	1082	
Doty's Bridge	1004	1011	
Rough's.........................	1021	1028	
Saw Mill Run...................	1009	1016	
Bell's Mill's Run................	1025	1032	
Phillips' Summit................	1037	1044	
Kissinger's Summit	1048	1055	
Two Lick Creek	1037	1044	
Reed's	1138	1145	
Indiana Terminus	1304	1311	

(*a*) With the Main line Pennsylvania R. R. on the side of Chestnut Ridge, high above the bed of the river.

(*b*) With the Indiana and Blairsville Branch

(*c*) Market Street Station, in Blairsville.

Digitized by Google

XXVI. West Penn R. R.

The levels of the West Penn R. R. were copied from a profile in the office of the Pennsylvania R. R. Company, at Philadelphia.

The datum is mean high tide in the Schuylkill River, at Philadelphia. In the second column seven feet are added to reduce to mean Atlantic Ocean Level.

This Railroad follows down the valley of the Kishkiminitas from Blairsville to Freeport, sometimes using the bed of the old State Canal.

STATIONS.	Above Tide.	Ocean Level.	
Blairsville (*a*)..............XXV	1004	1011	
Livermore......................	938	945	
Saltzburg (*b*)	884	891	
Fairbank's (*c*)............XXVII	926	933	
Helma	1010	1017	
Salina..........................	948	955	
North West.....................	887	894	
Roaring Run	823	830	
Apollo	816	823	
Townsend's Summit	880	887	
Grinder's	820	827	
Hill's Mill......................	773	780	
A. V. R. R. Crossing (*d*)........	778	785	
Freeport (*e*).............XXVIII	763	770	
Sligo	768	775	
Karn's	761	768	
Natrona.........................	761	768	
Tarentum	750	757	
Bailey's Run	746	753	
Springdale	742	749	
Harmersville	736	743	
Fairview	734	741	
Ross	738	745	
Sharpsburg (*f*)	732	739	
Bennett's......................	734	741	
Duquesne Borough.............	734	741	
Allegheny City (*g*).............	736	743	
Allegheny City (*h*)	738	745	
Allegheny City (*i*).............	736	743	
Terminus (*j*)	734	741	

(*a*) Market Street Station, Blairsville.

(*b*) Market Street, Saltzburg.

(*c*) Coal R. R. here connects, see next table XXVII.

(*d*) Crossing Allegheny Valley R. R.

(*e*) Second Street, Freeport.

(*f*) Main Street, Sharpsburg.

(*g*) Sycamore Street, Allegheny City.

(*h*) Chestnut Street, Allegheny City.

(*i*) East Lane, Allegheny City.

(*j*) Opposite Pittsburgh and connecting with the Pittsburgh, Fort Wayne and Chicago R. R. lines.

Digitized by Google

XXVII. Branch of W. P. R. R.

The levels on the Branch of the West Penn Railroad from Fairbank's Station to the Coal Mines were furnished by Mr. George W. Leuffer, C. E. The datum 0 is at grade of W. P. R. R., Fairbank's Station.

STATIONS.	Above Tide.	Ocean Level.	
Fairbank's Junction.......XXVI	926	933	
Grade near Mines................	1111	1118	
Bottom of Coal Bed.............	1133	1140	

XXVIII. Butler Branch W. P. R. R.

The levels on the Butler Branch Extension of the West Penn R. R. were furnished by Mr. Antes Snyder, Engineer, Springdale, Allegheny County, Pa.

There is an unexplained difference of 29.5 feet between the Butler Branch R. R. grade and the West Penn R. R. grade at Freeport, where they ought to be the same.

Another list was obtained from Mr. J. M. C. Creighton, differing very slightly from Mr. Snyder's; but still leaving *an unexplained difference of 27 feet at Freeport.*

The second column in the first table gives Mr. Snyder's levels *let down* 29½ *feet*, and in the second table Mr. Creighton's levels let down 27 feet.

The third column has seven feet added to reduce to mean Atlantic Ocean Level.

The datum of both tables is called "Mid Tide" at Philadelphia, which would require an addition of only 3.349 feet (instead of 7) to his original figures. See foot note on page 64. But this "Mid-Tide" may be a mistake for the "Mean High Tide" of the Pennsylvania R. R. Company's datum and is so taken.

STATIONS.	Mid Tide Philada.	2d Column.	Ocean Level.	
Freeport Junc....XXVI	792.5 †	763 ‡	770	
Buffalo	792.5	763	770	
Monroe.................	865.5	836	843	
Sarver's................	1056	1026.5	1034.5	
Saxon...................	1254.5	1225	1232	
Delano	1255.5	1226	1233	
Dilke's..................	1335	1305.5	1313.5	
Summit ‖	1344.5	1315	1322	
Great Belt City.........	1286.5	1257	1264	
Summit §................	1328	1298.5	1306.5	
Herman.................	1323.5	1394	1301	
Bunker's	1285.5	1256	1263	
Butler ....A	1031.5	1002	1009	

† Levels furnished by Mr. Antes Snyder.
‡ Elevation on profile of West Penn R. R. at Freeport.
‖ West of Dilke's.
§ East of Herman.

Digitized by Google

STATIONS.	Mid Tide Philada.	2d Column.	Ocean Level.
Freeport Junc....XXVI	790 †	763 ‡	770
Buffalo................	788	761	768
Harbison...............	824	797	804
Monroe.................	862	835	842
Sarver's...............	1052	1025	1032
Saxonberg..............	1227	1200	1207
Delano	1252	1225	1232
Dilke's................	1337	1310	1317
Great Belt.............	1285	1258	1265
Herman.................	1318.50	1291	1298
Bunker.................	1288.38	1261	1268
Butler. ....B	1030	1003	1010

XXIX. Ligonier Valley R. R

The levels on the Ligonier Valley R. R. were copied from notes in possession of Mr. George L. Miller, C. E., Pittsburgh, Pa. The datum is Pennsylvania R. R. at Latrobe. To which add 1144 for high tide at Philadelphia.

STATIONS.	Above Tide.	Ocean Level.
Ligonier.........................	1144	1151
Mill Creek.....(Surface of water)	1131	1138
Coal Pit Run.....................	1132	1139
Schriner's Run...................	1127	1134
Turnpike Crossing (*a*)............	1123	1130
Butler Milk Falls (*b*)............	1123	1130
Baker's Saw Mills (*c*)............	1117	1124
Little Rock Hollow...............	1096	1103
Big Rock Hollow................	1080	1107
Kellog's Hollow.................	1068	1075
Iron Ore (*d*).....................	1040	1047
Johnson's Forge.................	1036	1043
Derry Road Crossing............	1030	1037
Mitchell's Run (*e*)....	1029	1036

XXX. S. W. Pennsylvania R. R.

The levels of the South West Pennsylvania R. R. were furnished by Mr. G. W. Leuffer, Engineer.

The datum or base of levels is ordinary High Tide at Philadelphia.

† Elevations furnished by Mr. J. M. C. Creighton, Superintendent, West Penn. Division, Pennsylvania R. R.

‡ Elevation on profile of West Penn R. R. at Freeport.

(*a*) Greensburg and Stoystown.

(*b*) Loyalhanna Creek.

(*c*) At a point opposite Baker's Saw Mills.

(*d*) Out-crop of iron ore on line of R. R. 7 miles from Ligonier and 3 miles from Latrobe.

(*e*) Near Latrobe on the Pennsylvania R. R. Table I.

Digitized by Google

STATIONS.	Above Tide.	Ocean Level.	
Greensburg Junction (*a*)........I	1093	1100	
East Greensburg................	1055	1062	
Huffs..........................	994	1001	
County Home..................	972	979	
Fosterville.....................	960	967	
Youngwood	950	957	
Jack's Run......................	947	954	
Paintersville...................	945	952	
Sewickley Creek...............	936	943	
Hunker's.	938	945	
Bethany........................	1044	1051	
Tarr's...........................	1092	1099	
Stoner's Summit...............	1138	1145	
Hawk Eye......................	1060	1067	
Scottdale	1035	1042	
Jacob's Creek..................	1027	1034	
Everson	1027	1084	
Valley Works..................	1068	1075	
Pennsville Summit.............	1086	1093	
Pennsville......................	1047	1054	
Davidson.......................	891	898	
Connellsville...................	908	915	

(*a*) Junction with Pennsylvania R. R. near Greensburg.

XXXI. Yohiogheny R. R.

The elevations on the Yohiogheny R. R. were copied from notes in the possession of Mr. John F. Wolf, Engineer Pennsylvania Gas Coal Co., Irwin's Station, Westmoreland County, Pa.

The datum is Pennsylvania R. R. at:

STATIONS.	Above Tide.	Ocean Level.	
Irwin's Stat. P. R. R. (*a*).......I	877	884	
Shaft No. 2.....................	986	993	
Tunnel	1104	1111	
Chamber's......	1075	1082	
McGrew's.......................	974	981	
Millgrove	926	933	
Little Sewickley (*b*)............	797	804	
Marchand's (*c*)..................	763	770	
Yohiogheny (*d*).................	776	783	
Sewickley Station (*e*)...........	773	780	
R. R. Junction (*f*)..............	761	768	

(*a*) Junction with Pennsylvania R. R. at Irwin's Station.
(*b*) First Crossing Little Sewickley Creek.
(*c*) Yohiogheny Mine, No. 1, Shaft No. 3, elevation of Coal, 720'.4 above Tide.
(*d*) Yohiogheny Mine, No. 2, elevation of Coal 776'.4 above Tide.
(*e*) Mine No. 4, elevation of Coal opening at this point 800'.4 above Tide.
(*f*) Junction with Pittsburgh and Connellsville R. R.

Digitized by Google

II. READING SERIES.

L. Philadelphia and Reading R. R.

The elevations at the following points on the Philadelphia and Reading Railroad and Branches, were furnished by Mr. Wm. Lorenz, Chief Engineer.

The number of stations given in the tables, are few, but no others could be obtained.

The datum is *mid tide* at Philadelphia.

To this must be added 3.319 feet to reduce to Atlantic Ocean Level.

STATIONS.	Mean Tide.	Ocean Level.	
Philadelphia (*a*)................			
Nicetown Summit (*b*)........LI	111	114	
Belmont........................			
West Falls......................			
Pencoyd			
West Manayunk................			
Mill Creek.......................			
West Spring Mill			
West Conshohocken.............			
Swede Furnace			
Bridgeport (*c*)...............LII			
Merion..........................			
Port Kennedy (*c*)............LII			
Valley Forge			
Perkiomen Junction (*d*)......LIV			
Phœnixville (*e*).............LIII	105	108	
Mingo			
Royer's Ford....................			
Limerick			
Pottstown (*f*)...............LV	146	149	
Douglassville			
Monocacy			
Birdsboro (*g*)..................	170	173	
Exeter			
Neversink.......................			
Reading (*h*)...LVI, LVII, LVIII, LIX.......................	264	267	
Tuckerton.......................			
Leesport.........................	293	297	
Mohrsville			
Shoemakersville			
Hamburg........................	361	364	
Port Clinton (*i*)............LXII	397	400	
Auburn (*j*)................LXIII	457	460	
Landingville....................			
Schuylkill Haven (*k*)......( )	520	523	
Mount Carbon..................	591	594	
Pottsville (*l*) LXVI	603	606	

a Richmond Street Bridge, near the Coal Depots on the Delaware River.

b In Philadelphia, near the Germantown Road. The Germantown R. R.

LI. Germantown and Norristown Branch P. & R. R. R.

STATIONS.	Mean Tide.	Ocean Level.	
Philadelphia (*a*)................I	39	42	
Nicetown (*b*)....................	132	135	
Columbia Avenue......See below			
New York Junction..			
Tioga..........................			
Wayne			
Fisher's.......................			
Duey's (or Wistar Street)........			
Shoemaker's....................			
Church Lane...................			
Germantown Depot (*m*)..........	212	215	
Chestnut Hill	404	407	
Philadelphia....................			
Columbia Avenue .....See above	39	42	
New York Junction.............			
East Falls......................			
School Lane....................			
Wissahickon			
Schur's........................			
Manayunk			
Springfield.....................			
Shawmont......................			
Princeton			
Lafayette......................			
Spring Mill			
Conshohocken			
Potts Landing..................			
Magee's........................			
Norristown (*n*)..............CIII	62	65	

crosses the P. & R. R. R. in Nicetown on a bridge at an elevation of 132 (135). feet; but not at this summit. Table LI.

c Norristown opposite Bridgeport is given in this list as 62 (65.) See Table LI. Bridgeport is at the Junction of the Chester Valley R. R. See Table LII. R. R. to King of Prussia; no levels furnished.

d Perkiomen R. R.

e Pickering Valley R. R.

f Colebrookdale R. R.

g Wilmington and Reading R. R.

h Lebanon Valley R. R. Reading and Columbia R. R. East Penn R. R.

i Little Schuylkill R. R.

j Schuylkill and Susquehanna R. R.

k West Branch R. R.

l Mill Creek R. R. Schuylkill Valley R. R.

---

a Depot at the corner of 9th and Green Streets.

b Crosses the P. & R. R. R. on a bridge, but not at the Nicetown Summit mentioned in Table L.

m Probably the old Depot.

n The N. Penn. R. R. level, Stony Creek branch, is 50 (62 Ocean level).

Digitized by Google

LII. Chester Valley Railroad

The levels on the Chester Valley Railroad, were furnished by Mr. W. H. Holstein, Secretary of the Chester Valley Railroad Company.

The road connects with the Philadelphia and Reading Railroad at Bridgeport, and with the Pennsylvania R. R. at Downingtown.

The base of the levels is *mid tide* at Philadelphia. Add 3.349 to reduce to Ocean level.

STATIONS.	Mean Tide.	Ocean Level.
Bridgeport (*a*)..................L	73	76
Shainlines........................	133	136
Henderson's.......................	162	165
King of Prussia...................	187	190
Centreville	199	202
Gardens...........................	222	225
Howellville.......................	218	221
Paoli Road........................	235	238
Cedar Hollow......................	243	246
Lee's.............................	276	279
Valley Store......................	292	295
Mill Lane	312	315
White Horse.......................	336	339
Exton.............................	321	324
Oakland...........................	298	301
Baldwin's.........................	296	299
Downingtown (*b*)...............I	264	267

LIII. Pickering Valley R. R.

Of this line only one level was furnished.

Datum (Reading R. R.) mean tide at Philadelphia. Add 3.349 for Ocean level.

STATIONS.	Mean Tide.	Ocean Level.
Phœnixville L	(105)	(108)
French Creek....................		
Kimberton		
Pikeland		
Chester Springs		
Cambria.........................		
Byer's Eagle Summit............	450	453

a Opposite Norristown, Table L.

b On the Pennsylvania R. R.

Digitized by Google

LIV. Perkiomen R. R.

STATIONS.	Mean Tide.		
Perkiomen Junction (*a*)........L			
Oaks..........................			
Doe Run			
Yerke's			
Collegeville...	151	154	
Rahn's			
Grater's Ford			
Skippack			
Schwenksville	149	152	
Green Land	245	248	
Emaus Junction (*b*)..........LXI			

a Reading R. R.
b East Penn R. R.

LV. Colebrookdale R. R.

STATIONS.	Mean Tide.	Ocean Level.	
Pottstown (*a*)...................L	(146)	(149)	
Glasgow			
Manatawny....................			
Iron Stone			
Colebrookdale			
Boyertown	388	391	
New Berlin			
Bechtelsville			
Mt. Pleasant..................	466	469	
Rittenhouse Gap..............			
Alburtis (*b*)................LXI	(427)	(430)	

a Reading R. R.
b East Penn R. R.

LVI. Wilmington and Reading R. R.

STATIONS.	Mean Tide.	Ocean Level.	
Reading.......................L	(264)	(267)	
Birdsboro (*a*).................L	(170)	(173)	
Springfield.			
Coatesville (*b*).................I			
Chadd's Ford (*c*)................			
Wilmington (*d*)................			

a Junction with Philadelphia and Reading R. R.
b Crosses Pennsylvania R. R.
c Crosses Philadelphia and Baltimore R. R.
d Connects with Philadelphia, Wilmington and Baltimore R. R.

Digitized by Google

LVI. Wilmington and Reading R. R.

These levels of the Wilmington and Reading R. R. were furnished by Mr. E. Collings, Superintendent.

The datum, or base of levels, is low tide at Wilmington, Del. Relation of Ocean Level to this datum is unknown.

STATIONS.	Low Tide.	Ocean Level.	
Birdsboro Junction (*a*).........L	173	(173)	
Hampton........................	223		
White Bear.....................	349		
Geigertown.....................	432		
Cold Run.......................	525		
Joanna.........................	627		
Springfield....................	645		
Conestoga......................	647		
Isabella.......................	639		
E. B. & W. R. R. Crossing (*b*)..II	647		
Beaver.........................	603		
Honeybrook.....................	596		
Manor..........................	572		
Hibernia.......................	530		
Brandywine.....................	556		
Coatesville (*c*)................I	315		
Modena.........................	278		
Mortonville....................	260		
Laurel.........................	241		
Embréiville....................	231		
Glen Hall......................	218		
Northbrook.....................	209		
Seeds..........................	195		
Lenape.........................	183		
Pecopson.......................	180		
Chadd's Ford...................	175		
Smith Bridge...................	209		
Centre.........................	263		
Dupont's.......................	282		
Wilmington.....................	12	(12)	

a Junction with Philadelphia and Reading R. R. at Birdsboro, Berks County, Pennsylvania.

b Junction with E. Brandywine and Waynesburg R. R., Chester County, Pa.

c The Pennsylvania R. R. track on bridge just west of Coatesville Station is 62′ higher than track on W. & R. R. R. The elevation on Pennsylvania R. R. at the point where it crosses the W. & R. R. R. is 374′ above tide. By deducting 62′ according to Pennsylvania R. R. datum the elevation would be 312′. The datum of the Pennsylvania R. R. is high tide in Schuylkill River. The datum of W. & R. R. R. is low tide at Wilmington.

Digitized by Google

LVII. Lebanon Valley R. R.

STATIONS.	Mean Tide.	Ocean Level.	
Reading (*a*)....................L	(264)	(267)	
Schuylkill Bridge..............	262	265	
Sinking Springs (*b*)........LVIII	(341)	(344)	
Wernersville....................	376	379	
Heidelburg.....................	376	379	
Robesonia......................	428	431	
Sand Holes Summit..............	450	453	
Womelsdorf.....................	433	436	
Smiths'.........................	425	428	
Missimer's......................	425	428	
Richland........................	420	423	
Myerstown......................	460	463	
Prescott........................	503	506	
Avon...........................	467	470	
Lebanon........................	456	459	
C. R. R. Junction (*c*)..........LX	444	447	
L. & T. R. R. Junction (*d*)...LIX	439	442	
Annville........................	436	439	
Palmyra........................	443	446	
Spring Creek....................	384	387	
Hummelstown..................	360	363	
Swatara Creek..................	355	358	
Swatara Hills Summit...........	428	431	
Rutherford's....................	425	428	
Paxton..........................	363	366	
Harrisburg (*e*)...................I	308	311	

a Reading R. R.
b Reading and Columbia R. R.
c Cornwall R. R. Junction.
d Lebanon and Tremont R. R. Junction.
e West Line of Lebanon Valley Depot, Harrisburg, which, however, according to Pennsylvania R. R. Table I, is 315.5; probably more correct than 308.

LVIII. Reading and Columbia R. R.

STATIONS.	Above Tide.	Ocean Level.	
Reading........................L	(264)	(267)	
Sinking Springs (*a*)........LVII	341	344	
Deep Cut (*b*)....................	566	569	
Fitztown........................			
Reinhold's......................			
Union..........................			
Ephrata........................	378	381	

a Junction with the Lebanon Valley Road.
b South Mountain Summit.

Digitized by Google

LVIII. Reading and Columbia R. R.—CONTINUED.

STATIONS.	Above Tide.	Ocean Level.	
Rothville Summit (*c*)............	401	404	
Litiz..............................			
Manheim...........................			
Sellers............................			
Lancaster Junction..............			
Landisville (*d*)..................I	397	400	
Bruckhart's.......................			
Ironville..........................			
Kauffman's.......................			
Chestnut Hill Summit...........	582	585	
Columbia (*e*)...................I	257	260	

c This summit comes in *somewhere* between Ephrata and Landisville.

d Crosses Pennsylvania R. R. *on grade*. It is given as 398 (405) in Table I, — a difference in the *Ocean Level* column of (5) feet.

e The Pennsylvania *Ocean Level* grade here is (251) at the depot on the street, lower down on the hill slope.

LIX. Lebanon and Tremont R. R.

STATIONS.	Mean Tide.	Ocean Level.	
Lebanon Junction (*a*).......LVII	(439)	(442)	
Heilmansdale....................	505	508	
Bunker Hill......................			
Jonestown........................			
Union Forge......................			
Swatara Gap......................			
Murray............................			
Mifflin............................			
Irving.............................			
S. & S. R. R. Junc. (*b*)....LXIII	491	494	
Pinegrove........................			
L. G. Ex. R. R. Junc. (*c*)....(..)			
Tremont (R. R. Junc.) (*d*)...(..)			
Donaldson........................	901	904	
Kalmia Colliery..................	1128	1131	

LX. Cornwall R. R.

NOTE.—The levels on the Cornwall Railroad were copied from a profile furnished by Mr. A. Wilhelm, President of the Company.

Reading R. R. datum, Mean Tide at Philadelphia. Add 3.349 feet for ocean level.

Lines have been surveyed south to Mount Hope, and to Manheim.

a Lebanon Valley R. R.

b Schuylkill and Susquehanna R. R.

c Lorberry Gap Extension R. R.

d Mine Hill R. R.; Lyken's Valley R. R.

Digitized by Google

STATIONS.	Mean Tide.	Ocean Level.	
Lebanon Junction (a).......LVII	444	447	
Cumberland Street..............	425	428	
Plank Road.....................	438	441	
Killian's Road.................	534	537	
Coleman's Road.................	534	537	
Furnace Run....................	539	542	
Cornwall (b)...................	576	579	

a Junction with Lebanon Valley R. R. near Lebanon.
b Opposite the Middle of the Ore Hill.

LXI. East Penn R. R.

STATIONS.	Mean Tide.	Ocean Level.	
Reading (a)...................L	(264)	(267)	
Temple.........................			
Blandon........................	405	408	
Fleetwood......................			
Lyons..........................	460	463	
Bower's........................			
Topton Junction (b)............	471	474	
Mertztown......................			
Shamrock.......................			
Alburtis Intersection (c)......LV	427	430	
Millerstown....................			
Emaus Station (d)...........LIV	417	420	
Penn Junction (e)..............	260	263	
Allentown......................			

a Reading R. R.
b Branch R. R. to Kutztown.
c Fogelsville R. R.—Colebrookdale R. R.
d Perkiomen R. R.
e Lehigh Valley R. R., just below Allentown, where the 260 (263) elevation is supposed to apply.

LXII. Little Schuylkill R. R.

STATIONS.	Mean Tide.	Ocean Level.	
Port Clinton (a)..............L	(397)	(400)	
Drehersville...................			
Ringgold.......................	541	544	
Hecla..........................			
Reynolds.......................			
Tamaqua (b)....................	787	790	

a Reading R. R.
b South side of Broad Street.—Mountain Link and Schuylkill Valley R. R. —East Mahanoy R. R.

Digitized by Google

LXIII. *Schuylkill and Susquehanna R. R.*

STATIONS.	Mean Tide.	Ocean Level.	
Auburn Junction (*a*)...........L	(457)	(460)	
Jefferson........................			
Summit........................			
White Horse....................			
Stanhope			
Pinegrove Junction..............	511	514	
L. & P. R. R. Junction (*b*)..LIX	(491)	(494)	
Ellwood.			
Gold Mine.......................			
Rausch Gap			
Cold Spring			
Yellow Spring..................			
Rattling Run.			
Forge..........................			
Dauphin (*c*)...................			
Rockville (*d*)..................I	(348)	(350)	

a Reading R. R.
b Lebanon and Pinegrove R. R., or Lebanon and Tremont.
c East side of the Susquehanna River.
d East side of Susquehanna River, crossing Pennsylvania R. R. at grade, at the east end of the long bridge, 5 miles above Harrisburg.

LXIV. *Mine Hill and Schuylkill Haven R. R.*

STATIONS.	Mean Tide.	Ocean Level.	
Schuylkill Haven (*a*)...........L	(520)	(523)	
Westwood Junction	654	657	
Summit	860	863	
Tremont........................	758	761	
Westwood Junction, as above....	(654)	(657)	
Minersville	684	687	
Mine Hill Gap..................	816	819	
Glen Carbon.......	1136	1139	
Head of Mine Hill Plane, No. 1 ..	1519	1522	
Foot of Gordon Plane...........	773	776	
Centralia...................CXV	1465	1468	
Potts Colliery, Locust Dale......	1095	1098	

a Junction with Philadelphia and Reading R. R.

Digitized by Google

LXV. *Catawissa and Williamsport R. R.*

STATIONS.	Mean Tide.	Ocean Level.	
Tamaqua (*a*)............LXVIII	(787)	(790)	
East Mahanoy Junction (*b*)......	(1093)	(1096)	
Tamenend (*c*)..................	1291	1294	
Quakeake Junction (*d*)......CXV	1350	1353	
Summit	1542	1545	
Girard..........................			
Girard Passing..................			
Brandonville....................			
Ringtown	1332	1335	
Beaver..........................			
McAuley	759	762	
Mainville.......................	674	677	
D. W. & H. R. R. (*e*)......CXVI	476	479	
Catawissa	474	477	
North Branch (*f*)..............	481	484	
Rupert (*g*)			
Danville........................	493	496	
Mooresburg......................			
Pottsgrove......................	494	497	
Dougal	501	504	
Milton..........................			
P. & E. R. R. Crossing (*h*) CCXIII	480	483	
Datesman's......................			
West Branch (*i*)...............	475	478	
New Columbia..................			
White Deer......................	486	489	
Allenwood.......................			
Fritz...........................			
Montgomery			
P. & E. R. R. Crossing (*j*) CCXIII	500	503	
Susquehanna River (*k*).........	505	508	
Muncy	504	507	
Hall's..........................	521	524	
Montoursville...................	534	537	
Loyalsock Creek (*l*)	535	538	
P. & E.R.R. Crossing (*m*) CCXIII	542	545	
Williamsport Depot (*n*)........	530	533	

a b East Mahanoy R. R.
c Junction with Lehigh and Susquehanna Division of Central R. R. of N. J.
d With Lehigh Valley R. R.
e Crossing Danville, Hazelton and Wilkesbarre R. R. below Catawissa.
f Susquehanna River, water 29′ below rail.
g Junction with Lackawanna and Bloomsburg R. R.
h Crossing P. & E. R. R. (Milton).
i Susquehanna River, West Branch, water 28′ below rail.
j Crossing P. & E. R. R. (Montgomery).
k Water 30′ below rail.
l Water 13′ below rail.
m Crossing P. & E. R. R. (Williamsport).
n The level of the Philadelphia and Erie R. R. at this point is given in Table CCXIII, as 510.48 feet above Ocean Level.

Digitized by Google

LXVI. Mill Creek R. R.

STATIONS.	Mean Tide.	Ocean Level.	
Pottsville (*a*)..................L	(603)	(606)	
Mount Carbon (*a*)..............L	(591)	(594)	
Mill Creek Junction..............	622	625	
Port Carbon (*b*)...........LXVII	627	630	
Dormer's			
St. Clair.........................			
Lanigan Furnace.................	706	709	
John's Mines....................	827	830	
New Castle......................	875	878	
Head of Grade...................			
Frackville.......................			

a a Philadelphia and Reading R. R.
b Junction with Schuylkill Valley R. R.

LXVII. Schuylkill Valley R. R.

STATIONS.	Mean Tide.	Ocean Level.	
Pottsville (*a*)..................L			
Mt. Carbon (*a*)................L			
Port Carbon (*b*).............LXVI			
Eagle Hill.......................			
Cumbola.........................			
New Philadelphia			
Middleport......................	712	715	
Brockville.......................			
Tuscarora.......................	895	898	
Newkirk.........................			
Tamaqua (*c*)................LXII	(787)	(790)	

a a Philadelphia and Reading R. R.
b Junction with Mill Creek R. R.
c Junction with Little Schuylkill R. R.

LXVIII. East Mahanoy R. R.

STATIONS.	Mean Tide.	Ocean Level.	
Tamaqua (*a*).........LXII, LXV	(787)	(790)	
East Mahanoy Junction.... LXV	1093	1096	
" " Tunnel, south end	1312	1315	
" " " north end	1334	1337	
Mahanoy City Depot........CXV	1235	1238	

a End of Little Schuylkill R. R. Catawissa and Williamsport R. R.

Digitized by Google

LXIX. *Mahanoy and Shamokin R. R.*

STATIONS.	Mean Tide.	Ocean Level.	
Head of Grade (*a*)	1472	1475	
Head of Mahanoy Plane	1479	1482	
Foot of Mahanoy Plane	1127	1130	
St. Nicholas Colliery	1155	1158	
New Boston Colliery	1520	1523	
Ashland Depot	881	884	
Summit	1155	1158	
Keystone	1025	1028	
Benjamin Franklin Colliery	1175	1178	
Locust Summit	1238	1241	
Monteliers Colliery	1072	1075	
Coal Ridge Colliery, No. 2	1131	1134	
Preston Colliery, No. 1	1090	1093	
Cuyler Colliery, Raven Run	1360	1363	
Girardville	1051	1054	
Shenandoah City Depot	1244	1247	
Head of Big Mine Run Plane	1275	1278	
Locust Gap Junction	1029	1032	
Greenback Colliery	895	898	
Shamokin Depot	730	733	
Trevorton Colliery	760	763	
Herndon Junction (*b*)	423	426	

a South side Broad Mountain Summit.

b Junction with Northern Central R. W. at Herndon Station, 13½ miles from Trevorton.

NOTE. There are scores of small branching colliery roads and tracks to coal mines not mentioned in the foregoing tables. Civil and mining engineers in the Coal Region are earnestly requested to furnish all the authentic levels of the intersections of such roads, levels of switches, levels of mouths of gangways, and levels of determinate recognizable points on the surface, high and low, in their possession, to make this portion of the hypsometrical records of Pennsylvania as complete and useful as possible. [J. P. L.]

LXX. *Schuylkill Canal.*

The elevations on the Schuylkill Canal, were copied from a list furnished by Mr. James F. Smith, Chief Engineer, Reading, Penna.

The datum is mid tide, Philadelphia. The levels are deduced from a survey made in 1846.

Digitized by Google

Schuylkill Navigation Company. Elevation of Combs of Dams.

NAMES OF DAM.	No.	Above Mid-Tide.	Ocean Level.	Name of Town.
Fairmount	32	10	13	
Flatrock	31	36.10	39	
Plymouth	30	45.87	49	Conshohocken.
Norristown	29	57.36	60	
Catfish	28	62.19	65	
Pawlings	27	66.49	69	Perkiomen.
Black Rock	26	84.61	88	Phœnixville.
Vincent	25	102.07	105	
Lewis	24	177.86	181	
Poplar Neck	23	184.88	188	Lower Reading.
Kissingers	22	204.38	207	
Shepps	21	213.09	216	
Leizes	20	221.46	224	
Felix's	19	236.27	240	
Herbine's	18	265.95	269	Leesport.
Kernsville	17	364.93	368	
Blue M'tn.	16	389.83	393	
Hummels	15	409.03	412	
Lords	14	432.98	436	
Cross Cut	13	443.93	447	Auburn.
Dam No.	12	451.23	454	
" "	11	471.58	475	
" "	10	476.93	480	
" "	9	483.33	486	
" "	8	490.63	494	
" "	7	509.23	512	Schuylkill Haven.
" "	6	551.38	554	
" "	5	574.36	577	Second Mountain.
" "	4	583.83	587	Mount Carbon.
" "	3	592.23	595	" "
" "	2	613.83	617	Palo Alto.
" "	1	618.63	622	Port Carbon.

NOTE.—Levels as taken from a profile in the Penna. Canal Co'.s Office, at Harrisburg, made under the direction of J. Dutton Steele, Civil Engineer, in 1851.

TOWNS.	Above Tide.		
Mount Carbon	620		
Schuylkill Haven	511		
Port Clinton	392		
Reading	195		
Pottstown	147		
Norristown	49		

LXXI. *Union Canal.*

The elevations on the Union Canal, were copied from a statement, giving number and lifts of locks, furnished through the kindness of Mr. B. B. Lehman, of Lebanon, Pa., formerly Chief Engineer and Genral Superintendent of the Union Canal.

Digitized by Google

Elevation of Locks on Union Canal from Lebanon, Eastward.

NO. OF LOCK.	Above Tide.	Ocean Level.	
Lock No. 1	475.50		
" 2	471		
" 3	466.50		
" 4	462		
" 5	457.50		
" 6	453		
" 7	447.50		
" 8	440.50		
" 9	433.50		
" 10	427.50		
" 11	421.50		
" 12	414.50		
" 13	407.50		
" 14	401.50		
" 15	395.50		
" 16	387.50		
" 17	379.50		
" 18	373.50		
" 19	368.50		
" 20	362.50		
" 21	356.50		
" 22	351.50		
" 23	346.50		
" 24	340.50		
" 25	334.50		
" 26	328.50		
" 27	322		
" 28	315.50		
" 29	310.50		
" 30	305.50		
" 31	300.50		
" 32	295.50		
" 33	290.50		
" 34	285.50		
" 35	280.50		
" 36	275.50		
" 37	269.50		
" 38	264.50		
" 39	258.50		
" 40	253.50		
" 41	247.50		
" 42	241.50		
" 43	235.50		
" 44	230.50		
" 45	225.50		
" 46	220.50		
" 47	215.50		
" 48	210.50		
" 49	205.50		
" 50	200.50		
" 51	192.50		
" 52	185.50		
" 53	179		
" 54	169		

Digitized by Google

Lebanon (or Summit Level Union Canal) 480
Middletown (Mouth of Swatara Creek) 266
Reading (Schuylkill River) 169
Pinegrove (Basin at former head of Navigation) 483½

Elevation of Locks on Union Canal from Lebanon, Westward.

NO. OF LOCK.	Above Tide.	Ocean Level.	
Lock No, 1	474.60		
" 2	469.20		
" 3	463.80		
" 4	458.40		
" 5	453		
" 6	447.60		
" 7	442.20		
" 8	436.80		
" 9	431.40		
" 10	426		
" 11	420.60		
" 12	415.20		
" 13	409.80		
" 14	404.40		
" 15	399		
" 16	393.60		
" 17	384.60		
" 18	376.60		
" 19	368.60		
" 20	362.60		
" 21	356.60		
" 22	351.10		
" 23	345.60		
" 24	340.10		
" 25	334.60		
" 26	329.60		
" 27	324.60		
" 28	319.60		
" 29	314.60		
" 30	309.60		
" 31	303.60		
" 32	297.60		
" 33	291.60		
" 34 (At Middletown)	285.60		
Susquehanna River, Mouth of Swatara Creek	266		

LXXII. Lebanon Valley R. R. (Steele.)

NOTE.—This list was copied from a profile in the office of the Pennsylvania Company, at Harrisburg, made under the direction of J. Dutton Steele, Civil Engineer, in 1857.

STATIONS.	Above Tide.	Ocean Level.	
Harrisburg I	314		
Hummelstown..................	362		
Palmyra	442		
Annville.......................	395		
Lebanon	460		
Myerstown	468		
Womelsdorf	440		
Reading	253		
Birdsboro	165		
Pottstown.....................	137		
Phœnixville....................	97		
Norristown.....................	58		
Manayunk Falls................	51		

III. LEHIGH SERIES.

C. North Pennsylvania R R

The levels on the North Pennsylvania R. R. were copied from the profile in the office of the Company, by permission of Mr. S. W. Roberts, Chief Engineer and General Superintendent.

The datum, or base of levels, is Philadelphia City datum, 8.733′ above mean surface of Atlantic Ocean. *Therefore 9 feet is added to make the second column.*

STATIONS.	City Datum.	Ocean Level.	
Philadelphia Depot (*a*)..........	19	28	
Cohocksink	25	34	
Diamond Street.................	30	39	
Somerset Street.................	69	78	
P. & R. Coal R. R. Crossing (*b*)..L	70	79	
Tioga Street	94	103	
Frankford Lane.................	92	101	
Fisher's Lane...................	110	119	
Green Lane......................	156	165	
Oak Lane........................	192	201	
City Line........................	184	193	
York Road.......................	176	185	
Cnelton Hills....................	181	190	
Paxon's Road...................	225	234	
Abingdon Junction (*c*)........CII	245	254	
Edge Hill........................	284	293	
Camp Hill.......................	169	178	
Edgehillville Road..............	167	176	
Fort Washington................	161	170	
Ambler..........................	190	199	
Pennllyn........................	230	239	
Gwynedd........................	262	271	

a At Willow Street.
b Crossing Philadelphia & Reading R. R.
c Intersection of Northeast Pennsylvania R. R. at Abington.

Digitized by Google

STATIONS.	City Datum.	Ocean Level.	
Wissahickon Creek..............	342	351	
Lansdale Junc. (*d*).....CIII, CIV	359	368	
Hatfield........................	302	311	
Zetty's Road....................	339	348	
Nigger Hill.....................	443	452	
Sellersville....................	322	331	
Tunnel..........................	444	453	
Koffler's Gap...................	521	530	
Bunker Hill.....................	519	528	
Quakertown......................	487	496	
Hilltop.........................	546	555	
Coopersburg.....................	540	549	
Summit (*e*)....................	591	600	
Koch's Mill.....................	364	373	
Yeager's Mill...................	339	348	
Wagner's Mill...................	279	288	
Hellertown......................	267	276	
Hampton.........................	267	276	
Shimersville R.R. (*f*)........CV	255	264	
Hess' Mill......................	259	268	
Zinc Works......................	238	247	
Bethlehem (*g*).................	228	237	

A profile in the office of the Pennsylvania Canal Company, at Harrisburg, made under the direction of J. Dutton Steele, Civil Engineer, in 1857, gives the following very different levels of some of the points mentioned in the above list, and of others not mentioned in it. Some of the names seem to have been altered or reversed:

Wingohocking (Frankford Lane?) 92; Fisher's Lane, 110; City Lane (Oak Lane?) 192; Edgehill (York Road?) 175; Edgehill, 284; Fort Washington, 158; Wissahickon (Ambler?) 190; Gwynedd, 229! North Wales, 377; Lansdale, 371; Nigger-Hill, 440; Sellersville, 311; Koffler's Gap, 524; Bunker Hill, 519; Quakertown, 489; Same's Gap, 597; Hellertown, 270; Bethlehem, 249.

The datum is "Tide."

CI. Delaware and Bound Brook R. R.

NOTE. For this road which is virtually a branch of the North Pennsylvania, leaving it at Jenkintown Station. See Appendix.
For the *Philadelphia and Newtown R. R.*, see under CLIII.

d Doylestown Branch and Stony Creek R. R. Crosses at Lansdale.

e Highest Point noted on profile of North Pennsylvania R. R. end of section 44, near Coopersburg, 591.50.

f Point of divergence of Shimersville Branch.

g The North Pennsylvania R. R. intersects the Lehigh Valley R. R. at this point.

Digitized by Google

CII. Northeast Pennsylvania R. R.

The levels on the Northeast Pennsylvania R. R. were furnished by Mr. S. W. Roberts, Chief Engineer and General Superintendent, N. P. R. R.

Base of levels, Philadelphia City datum, 8.733 above Ocean Level. Therefore nine feet is added to make second column.

STATIONS.	City Datum.	Ocean Level.	
Abington Junction (*a*)..........C	250	259	
Summit........................	333	342	
Willow Grove..................	250	259	
Heaton........................			
Pennepack Creek...............	160	169	
Fulmore.......................			
Hatsborough...................	220	229	
Hartsville....................	233	242	

a Junction with the North Pennsylvania R. R. near Abington.

CIII. Doylestown Branch N. P. R. R.

The elevations on the Doylestown Branch of the North Penn R. R. were furnished by Mr. S. W. Roberts, Chief Engineer.

Base of levels, Philadelphia City datum, 8.733 above Ocean Level.

STATIONS.	City Datum.	Ocean Level.	
Lansdale Junction (*a*)..........C	359	368	
Temperance Road...............	350	359	
Neshaminy Creek...............	260	269	
Road to Lexington.............	242	251	
Cooke's Run...................	242	251	
Bristol Road..................	294	303	
Doylestown (*b*)...............	338	347	

a Point of divergence from N. P. R. R. at, or near Lansdale.
b Depot Ground at Doylestown.

CIV. Stony Creek R. R.

The levels on Stony Creek R. R. were copied from a profile furnished through the kindness of Mr. A. R. Roberts, Assistant Engineer, N. P. R. R.

The datum was fixed on the assumption that the elevation of the water in the Schuylkill River pool *below* Norristown, stood 49′ above Mean Tide at Philadelphia. The elevation of the comb of the dam *at* Norristown, as shown by the notes of the Schuylkill Navigation Company, at Reading, Pa., is 57.36′ above mid tide at Philadelphia.

The third column is made by adding three feet (3.349) to reduce to Mean Tide at Philadelphia to Ocean Level.

Digitized by Google

STATIONS.	Above Assumed Datum.	Mean Tide.	Ocean Level.	
Lansdale Junc. (*a*)....C	*350	†359	362	
1st Mile Post...........	350	359	362	
2d Mile Post............	330	339	342	
Summit (*b*).......	350	359	362	
1st Crossing of Stony Cr.	215	224	227	
2d Crossing of Stony Cr.	142	151	154	
3d Crossing of Stony Cr.	104	113	116	
Norristown (*c*).......LI	50	59	62	

a With North Penn R. R. and with Doylestown Branch R. R.

* Elevation as shown on profile.

† Elevation of Railroad Crossing as shown on profile of North Penn. R. R. Levels at the other stations of the table are made to correspond with the level of North Penn R. R., by adding 9 feet to Mr. Roberts' original figures.

b Between Wissahickon and Stony Creek.

c The level given in Table LI, of the Philadelphia and Reading R. R., Germantown and Norristown Branch, at Norristown is 62 (65 Ocean Level).

CV. Shimersville Branch N. P. R. R.

STATIONS.	Above Tide.	Ocean Level.	
Junction (*a*)...................C	255	258	
Junction (*b*)..............CXIV	217	220	

a Point of divergence from N. P. R. R. near Bethlehem.

b Junction with Lehigh Valley R. R.

CVII. Lehigh and Susquehanna R. R.

Note.—This road runs on the north and east bank of the Lehigh River most of the way. Its levels are similar to those of the Lehigh Valley road on the opposite bank.

STATIONS.	Tide.	Ocean Level.	
Easton (*a*).....................			
Freemansburg..................			
Bethlehem (*b*)............CXIII	(240)	(243)	
Allentown Station...............			
Catasauqua (*c*)			
Laubach's.......................			
Siegfried's Bridge			
Treichler's......................			
Walnut Port.....................			
Lehigh Gap			

a Junction with Morris & Essex R. R.

b Junction with N. Penna. and with Lehigh and Lackawanna R. R's.

c Junction with Cat. & Fogelsville R. R.

Digitized by Google

STATIONS.	Tide.	Ocean Level.	
Parryville........................			
Weissport........................			
Lehighton........................			
Mauch Chunk (*d*)............. ...			
Penn Haven Junction			
Rockport			
White Haven (*e*)................			
Penobscot........................			
Ashley (*f*)			
Wilkesbarre.....................			
Pittston.........................			
Moosic			
Scranton (*g*)...................			
Green Ridge (*h*)................			

CVIII. Mauch Chunk and Switch Back R. R.

Mauch Chunk			
Summit Hill.....................			

CIX. Nesquehoning Valley R. R.

Mauch Chunk..................			
Nesquehoning..................			
Hauto			
Hometown			
Tamenend			

CX. Tamaqua Branch R. R.

Hauto			
Coledale			
Tamaqua			

CXI. Nescopec Branch R. R.

White Haven...			
Upper Lehigh..................			

CXII. Nanticoke Branch R. R.

Ashley			
Sugar Notch....................			
Hanover			
Nanticoke......................			
Wanamie.......................			

d Junction with Nesquehoning Valley Branch; M. C. Summit Hill and Switchback R. R.

e Junction with Nescopec Branch.

f Junction with Nanticoke Branch.

g Junction with Del. Lack. & Western R. R.

h Junction with Delaware & Hudson R. R.

Digitized by Google

CXIII. Lehigh and Lackawanna R. R.

The elevations on the Lehigh and Lackawanna R. R., were furnished by Mr. Charles Brodhead, President of the Company, who says, "Our surveys carry us into the *Wind Gap;* and the highest point on the Turnpike, *in the Gap*, we found to be 738 feet above Bethlehem, or 978 feet above tide." The road runs as far as Steuben, 15 miles.

STATIONS.	Mean Tide.	Ocean Level.	
Bethlehem Junction (*a*)....CVII	240	243	
Peter's Mills....................	255	258	
Shimer's.........................	287	290	
Reiter...........................			
Brodhead	315	318	
Steuben	333	336	
Bath	401	404	
Chapman..........................	576	579	

a With Lehigh and Susquehanna R. R. at Bethlehem, on the north side of the Lehigh River.

CXIV. Lehigh Valley R. R.

The levels on the Lehigh Valley R. R. were copied from a list furnished by Mr. Robert H. Sayre, Chief Engineer and General Superintendent, Lehigh Valley R. R.

The datum is Mean Tide, Delaware River, three feet being added for Ocean Level in the second column.

Note on the Lehigh Canal Levels.

By a printed list of levels in the possession of Mr. George Ruddle, of Mauch Chunk, it appears that there is a rise in the

Lower grand section of Slackwater Navigation, from the Delaware River to Mauch Chunk (46 miles), of..................	360′.87
Upper grand section, Mauch Chunk to Wright's Creek (26 miles), of.	599′.83
Upper grand section, Wright's Creek to Stoddart's Ville (miles), of....................................	336′.00
Adding to these figures, for the height of Bixler's Rift, Delaware Canal, above low tide in Delaware River.....................	160.40
we get the following heights of the Lehigh Slackwater System:	
At Mauch Chunk, 360.87 + 160.40 = ...	521.23
At Wright's Creek, 521.23 + 599.83 = ...	1121.10
At Stoddart's Ville, 1121.10 + 336 = ...	1457.10

STATIONS.	Mean Tide.	Ocean Level.	
Philipsburg (*a*).............CL	208	211	
Delaware River, here............	(148)	(151)	
Easton	202	205	
Redington.......................			
Freemansburg....................	219	222	

a 60′ above Delaware River, Junction with Central R. R. of N. J., Morris and Essex R. R., Belvidere and Delaware R. R.

Digitized by Google

STATIONS.	Mean Tide.	Ocean Level.	
Bethlehem......................	231	234	
North Penn R. R. Junction (*b*).C	247	250	
East Penn R. R. Junction...LXI			
Allentown......................	251	254	
Catasauqua.................CXV	277	280	
Hokindauqua............CXV *bis*			
Whitehall......................	297	300	
Coplay.........................			
Laury's........................	326	329	
Slatington.....................	363	366	
Lehigh Gap.....................	385	388	
Lehighton......................	461	464	
Mauch Chunk (*c*)..........CVIII	553	556	
Glen Onoko.....................			
Penn Haven Junction......CXVI	705	708	
Hickory Run....................			
Rockport (*d*).................	910	913	
White Haven....................	1150	1153	
Summit (*e*)...................	1742	1745	
Fairview (*f*).................	1675	1678	
Newport........................	1024	1027	
Warrior Run....................	710	713	
Sugar Notch....................	670	673	
South Wilkesbarre..............	550	553	
Wilkesbarre (*g*)..............	553	556	
Plainsville....................	550	553	
Pittston.................CXVIII	572	575	
Lackawanna Junction (*h*)....CLV	572	575	
Ransom.........................	584	587	
Falls	590	593	
McKunes'.......................	600	603	
Lagrange.......................	600	603	
Tunkhannock.............CXIX	614	617	
Vosburg........................	617	620	
Mehoopany	636	639	
Meshoppen (*i*)................	646	649	
Black Walnut...................	653	656	
Laceyville.....................	663	666	
Wyalusing......................	678	681	
Frenchtown	694	697	
Rumnerfield....................	700	703	
Standing Stone.................	706	709	
Wysauking	716	719	
Towanda (*j*)..............CXX	738	741	
Ulster.........................	743	746	
Athen's Bridge.................	776	779	
Waverly (*k*).............CLXII	823	826	

b Junction with East Penn. R. R. Elevation given by Philadelphia and Reading R. R. at this point 260′.
c 40′ above Lehigh River.
d 35′ above Lehigh River.
e Nescopeck Mountain.
f Top of Wyoming Mountain.
g 30′ above Susquehanna River.
h 35′ above Susquehanna River, Junction with Delaware, Lackawanna and Western R. R.
i 35′ above Susquehanna River at Meshoppen.
j 28′ above Susquehanna River at Towanda.
k 25′ above Chemung River. At Waverly joins the New York and Erie R. R.

Digitized by Google

CXV. Catasauqua and Fogelsville R. R.

The levels of the Catasauqua and Fogelsville R. R. were furnished through the courtesy of Mr. Joshua Hunt, President of the Company.

The datum is Lehigh Valley R. R. at Catasauqua; which is 277′ above tide; and therefore 280′ above Ocean Level, as shown in the second column.

STATIONS.	Above Catasauqua.	Ocean Level.	
Catasauqua	0	280	
Seiple's	183	463	
Jordan Bridge (*a*)	165	445	
Guth's	209	489	
Walbert	268	548	
Chapman	259	539	
Trexlertown (*b*)	129	409	
Spring Creek	101	381	
Alburtis (*c*)	173	453	
Lock Ridge	158	438	
Gardner	387	667	
Red Lion	511	791	
Rittenhouse Gap	658	938	

a Water in creek at Jordan Bridge, 81 feet = Catasauqua; 361′ = Tide.
b Allentown R. R. Crossing on grade.
c East Pennsylvania R. R. Crossing.

CXV bis. Trenton R. R.

NOTE. No levels of this road could be obtained.

CXVI. Lehigh Valley Coal Branches.

The elevations on the Branch Railroads owned by the Lehigh Valley R. R. Company were furnished by Mr. Robert H. Sayre, Chief Engineer and General Superintendent.

The datum is mean Tide, Delaware River.

STATIONS.	Mean Tide.	Ocean Level.	
Penn Haven Junction (*a*)	705	708	
Black Creek (*b*)	1015	1018	
Weatherly	1090	1093	
Hazle Creek Junction (*c*)	1325	1328	
Hazleton			
Eckley			
Hazel Creek Junction (*c*)	1325	1328	
Beaver Meadow	1355	1358	
Lewiston			
Jeanesville	1680	1683	
Yorktown Crossing (*d*)	1750	1753	

a With Lehigh Valley R. R.
b Leaves here the Quakeake R. R. or Mahanoy Division.
c Of the Beaver Meadow R. R. with the Hazleton R. R.
d Divide between the Lehigh and Susquehanna waters.

Digitized by Google

STATIONS.	Mean Tide.	Ocean Level.	
Audenreid	1735	1738	
Hartz's			
Quakake Junction (*e*)	1315	1318	
Delano (*f*)	1665	1668	
Mahanoy City Junction.....LXV	1552	1555	
Mahanoy City...........LXVIII	1230	1233	
Shenandoah	1268	1271	
Raven Run			
Centralia (*g*)..............LXIV	1484	1487	
Mount Carmel	1056	1059	
Locust Gap	1027	1030	
Fulton	960	963	
Shamokin (*h*)	730	733	
Zerbe Summit (*i*)	1073	1076	
Zerbe Colliery	905	908	

e Crosses at Yorktown the Catawissa R. R. Elevation (as given by Philadelphia and Reading R. R. at this point) 1350′ feet above tide!

f Delano is on the divide between Schuylkill and Susquehanna waters.

g Centralia is on the divide between the Mahanoy and Shamokin waters.

h Shamokin Station 70′ above the town.

i Zerbe Summit divides the Shamokin and Little Mahanoy waters.

CXVII. Danville, Hazleton and Wilkesbarre R. R.

The elevations on the Danville, Hazleton and Wilkesbarre R. R. were furnished by Mr. A. B. Starr, Assistant Engineer, P. & E. R. R.

The datum is *high* tide at the Schuylkill River, at Philadelphia. Add seven feet for Ocean Level.

STATIONS.	High Tide.	Ocean Level.	
Sunbury Junction (*a*)	436	443	
Kline's Grove	438	445	
Wolverton	435	442	
Kipp's Run	456	463	
Danville (*b*)	456	463	
Roaring Creek	452	459	
Catawissa	464	471	
R. R. Crossing (*c*)	463	470	
Mainville	582	589	
Mifflin Cross Roads	804	811	
Scotch Valley	1008	1017	
Summit	1030	1037	
Wolfton	1016	1023	
Rock Glen	914	921	
Gowan	992	999	
Tomhicken (*d*)	1221	1228	

a Shamokin R. R. with Northern Central R. R. at Sunbury.

b With Lackawanna and Bloomsburg R. R.

c Catawissa R. R. Crossing; Elevation of Catawissa R. R. at same point 476.

d With Lehigh Valley R. R.

Digitized by Google

CXVIII. Pennsylvania Coal Company's R. R.

Elevations on the Pennsylvania Coal Company's R. R. from Pittston (or Port Griffith) to Hawley were copied from a profile in the Company's office at Pittston, Pa., by permission of Mr. George Johnson, Engineer.

The datum is 0 at foot of Plane No. I = 567.'28 above Sea Level.

	STATIONS.	Profile.	Above Tide.
Loaded track going out from Pittston.	Head of Plane..........No. 1	108	675
	" " .... " 2	206	773
	" " .... " 3	246	813
	" " .... " 4	397	964
	" " .... " 5	495	1062
	" " (Dunmore) " 6	550	1117
	" " .... " 7	697	1274
	" " .... " 8	888	1455
	" " .... " 9	1077	1644
	" " .... " 10	1255	1822
	" " .... " 11	1217	1784
	Tunnel	1400	1967
	Base of Plane............No. 12	779	1346
	Head of Plane............No. 12	928	1495
	Hamlin	329	896
Empty track back to Port Griffith's.	Head of Plane..........No. 13	511	1078
	" " .... " 14	640	1207
	" " .... " 15	733	1300
	" " .... " 16	830	1397
	" " .... " 17	874	1441
	" " .... " 18	955	1522
	" " .... " 19	998	1565
	" " .... " 20	952	1519
	" " .... " 21	1040	1607
	" " .... " 22	246	813
	Foot of Plane .... " 22	64	631

CXIX. Montrose R. W.

Elevations on the Montrose Railway were furnished by Mr. James I. Blakslee, President of the Company.

The datum, or base of levels, is that of grade on the Lehigh Valley R. R. at Tunkhannock.

STATIONS.	Mean Tide.	Ocean Level.
Tunkhannock (*a*)..........CXIV	614	617
Marcy..........................	968	971
Lemon..........................	1044	1047
Avery..........................	982	985
Meshoppen Creek................	936	939
Lynn	1035	1038
Springville....................	1260	1263
Tylersville....................	1403	1406
Dimock	1510	1513
Hunter's.......................	1550	1553
Cool's.........................	1550	1553
Allenville	1652	1655
Montrose.......................	1659	1662

a Junction with Lehigh Valley R. R.

Digitized by Google

CXX. Barclay and Schrader R. R.

Elevations on the Barclay and Schrader R. R's were furnished by Mr. A. W. Stedman, Engineer of the Pa. & N. Y. R.R. & Coal Co., at Towanda, Pa., through the solicitation of Mr. James Macfarlane.

The datum is mean tide at Philadelphia.

STATIONS.	Mean Tide.	Ocean Level.	
Towanda (*a*). CXIV	732	735	
Towanda (*b*).....................	719	722	
Monroeton Junction (*c*)....CXXI	756	759	
Masontown (*d*)..................	788	792	
Greenwood..........................	817	820	
Lamoka.............................	1036	1039	
Foot of Plane (*e*)................	1265	1268	
Head of Plane (*f*)	1750	1753	
Schrader R. R.*			
R. R. Switch (*g*).................	1795	1798	
R. R. Switch (*h*).................	1782	1785	
Carbon Run (*i*)..................	1923	1926	
Lowest Point (*j*).................	1970	1973	
Summit............................	2035	2038	

*This Railroad, four miles long, connects the Barclay R. R. with the Schrader Coal Mines.

a Switch at Upper Depot.
b Barclay Depot.
c With State Line and Erie R. R.
d Barclay R. R. Bridge rail.
e *Elevation estimated.*
f Rail in Plane-house.
g Upper Switch connecting with Barclay R. R.
h Lower Switch connecting with Barclay R. R.
i Rail under Breaker is 1923′.
j Lowest Point of Coal near Breaker.

CXXI. State Line and Erie R. R.

Levels on the State Line and Erie R. R. were copied from a profile in the office of the Company at Towanda, Bradford County, Pa. There were no stations, or names of towns, noted on the profile, the elevations being marked at mile posts, and therefore, the stations have been located from J. A. Anderson's R. R. map. The levels as shown in this list may not be entirely correct; but it is the only record which could be found.

The datum is Mean Tide at Philadelphia.

STATIONS.	Mean Tide.	Ocean Level.	
Monroeton Junction (*a*).....CXX	756	759	
Wilcox............................	1117	1120	
New Albany.......................	1191	1194	
Miller's...........................	1324	1327	
Bushore........................(?)	1587	1590	
Bernice...........................	1852	1855	

a With Barclay R. R.

Digitized by Google

IV. DELAWARE SERIES.

CL. Philadelphia and Trenton R. R.

Levels on the Philadelphia and Trenton, and Belvidere Division of the Pennsylvania R. R. were furnished by Mr. F. B. Fiddler, Engineer in the office of the Company at Trenton, N. J. The levels were deduced from the original table of grades by Samuel H. Kneass, Engineer.

The datum of the Philadelphia and Trenton R. R. is mean tide at Philadelphia. The datum of the Belvidere Division of the Pennsylvania R. R. is water in canal at junction of feeder with Delaware and Raritan Canal near Trenton, which water level is four feet below the railroad track.

Philadelphia, Trenton and Belvidere Division, Pennsylvania R. R.

STATIONS.	Mean Tide.	Ocean Level.	
Philadelphia....................			
Kensington (*a*)..................	29	32	
Bridge over Frankford Creek....	24	27	
Frankford Station (*b*)............	29	32	
Bridesburg (*c*)..................	29	32	
Tacony..........................	31	34	
Bories..........................	32	35	
Cornwell's......................	36	39	
Eddington (*d*)..................	39	42	
Bristol (*e*)......................	18	21	
Tullytown.......................	17	20	
Penn Valley.....................	18	21	
Morrisville (*f*)..................	31	34	
Trenton Junction (*g*)............	60	63	
Washington's Crossing..........	64	67	
Prime Hope Saw Mills...........	CLI		
Lambertville....................	72	75	
Prallsville.....................	83	86	
Bull's Island (*h*)...............	94	97	
Warford's Rock.................	CLI		
Frenchtown.....................	125	128	
Milford.........................	137	140	
Holland.........................	CLI		
Reigelsville....................	163	166	
Carpenterville..................	175	178	
Phillipsburg (*)...........CXIV	195	198	
Martin's Creek..................	231	234	
Belvidere.......................	268	271	
Manunka Chunk.................	320	323	
Walker's Ferry Water Gap......	CLI		

a Frankford Road Crossing.
b Middle of Church Street.
c Middle of Bridge Street.
d Dunk's Ferry Road.
e Middle of Market Street.
f N. E. side of Washington Street.
g The railroad track is four feet above the water in the canal.
h Elevation of railroad, head of Bull's Island, 97′. Low water in Delaware River 74′.

* Lehigh Valley R. R.

Digitized by Google

CLI. Delaware River Levels.

NOTE.—The following levels of ordinary low water in Delaware River above *mean tide at Philadelphia* (= 3.349 above mean ocean level) were obtained in the office of the Philadelphia and Trenton R. R. at Trenton, from Mr. F. B. Fiddler, C. E., deduced from the original grade tables by Mr. S. H. Kneass.

PLACES.	Mean Tide.	Ocean Level.
Trenton		
Washington's Crossing	20	23
Prime Hope Saw Mills	35	38
Lambertville	49	52
Bull's Island	71	74
Head of Bull's Island	74	77
Warford's Rock	91	94
Frenchtown	104	107
1.7 miles above " (*a*)	107.7	111
Milford	111	114
4 miles above " (*b*)	121.8	125
Holland	116	119
1½ miles below Reigelsville	124.2	127
Reigelsville	127	130
⅞ mile above "	130	133
1.6 mile above "	133.8	137
Carpenterville	137	140
2½ miles below Phillipsburg (*c*)	148.6	151
Phillipsburg	157	160
1¾ mile above "	165.2	168
2.7 miles above "	170.4	173
7.6 miles above "	192.8	196
2.84 miles above Martin's Cr. (*d*)	200.4	204
4.14 miles above "	210.9	214
Belvidere	232	235
Manunka Chunk	262	265
Walker's Ferry at Delaware Water Gap	298	301

CLII. Delaware Canal.

Elevations on the Delaware Canal were copied from a map made under the direction of the Lehigh Coal and Navigation Company, in 1826, by Isaac A. Chapman. The map is in possession of Mr. George Ruddle, Mauch Chunk.

The datum is low tide Delaware River, 3.349 above Ocean Level.

a Huntingdon County, N. J., 31.7 miles above Trenton.
b " " " not the Milford of Pike County, Pa.
c Opposite Easton, in New Jersey.
d Above Easton, in Pennsylvania.

Digitized by Google

POINTS ON LINE OF CANAL.	Low Tide. Feet.	Inches
Trenton Falls; head; 49 miles below the mouth of Lehigh River	9	8
Gould's Rift; head	16	8
Yardleyville	18	
Scudder's Rift; head	24	8
Taylor's Rift; head	33	6
Buck Tail Rift; head	36	5
Will's Falls; head	49	9
New Hope	50	
33 miles below Lehigh River	53	3
Green Banks Rift; head	58	9
Gallopen's; head	68	3
Bull's Falls; head	72	2
26 miles below Lehigh River	72	9
Cut Bite Rift; head	77	4
Tumbling Dam Falls; head	89	1
Marshal's Island Rapids; head	100	7
Man of War Rift; head	102	3
Stunt's Falls; head	107	2
Firman's Falls; head	110	11
Nockamixon Falls; head	117	6
Linn's Falls; head	124	10
11 miles below Lehigh River	126	10
10 miles below Lehigh River	127	3
Durham Falls; head	130	3
9 miles below Lehigh River	130	4
Greavelly Falls; head	133	3
Rocky Falls; head	136	1
Ground Hog Rift; head	138	1
Old Sow Rift; head	145	7
Clifford's Rift; head	150	10
Bixler's Rift; head (*a*)	160	5

a This point is about one-half mile below the mouth of Lehigh River.

CLIII. Philadelphia and Newtown R. R.

NOTE.—See Appendix.

CLIV. Flemington R. R.

Levels on the Flemington R. R. were copied from a list prepared by Mr. F. B. Fiddler, in the R. R. office, at Trenton, N. J.

The datum is mean tide Delaware River, = 3.349 above Ocean Level.

STATIONS.	Mean Tide.	Ocean Level.	
Flemington Junction (*a*)......CL	73	76	
Mount Airy	147	150	
Ringoes	248	251	
Summit (*b*)	255	258	
Copper Hill	159	162	
Flemington	183	186	

a Junction with Belvidere and Delaware R. R.

b N. E. of Ringoes.

Digitized by Google

NOTE.—Two other short lists in New Jersey are here appended, on account of their connections with the Delaware River lines. Other New Jersey Railway levels are published by Prof. Cook in his Annual Reports of the Geological Survey of that State.

Morris and Essex R. R.

The Morris and Essex R. R. levels were furnished by Mr. James Archbald, Chief Engineer, Del. L. & W. R. R.

STATIONS.	Mean Tide.	Ocean Level.	
Phillipsburg.................CL	217	220	
Phalcony Creek.................	341	344	
Stewartsville..................	370	373	
Washington Depot..............	503	506	
Port Murray....................	585	588	

Belvidere and Newtown R. R.

NOTE.—The Belvidere and Newtown levels were copied from a list furnished by Mr. F. B. Fiddler, Trenton, N. J.

STATIONS.	Mean Tide.	Ocean Level.	
R. R. Junction (*a*)............CL	272	275	
Belvidere......................	283	286	
Sarepta........................	361	364	
Hope	478	481	
Howell P. O....................	562	565	
Summit	595	598	
Johnsburg......................	568	571	
Summit	628	631	
Newton.........................	607	610	

a Junction with B. D. R. R.

CLV. Delaware, Lackawanna and Western R. R.

Elevations on the D. L. & W. R. R. were copied from a profile in the office of the Company at Scranton, by permission of the Assistant Engineer, Mr. Bryson.

The datum is mean tide, Delaware River, = 3.349 above Ocean Level.

STATIONS.	Above Tide.	Ocean Level.	Corrected.
Junction (Central R.R. of N. J)..			
Washington (Morris & Essex R.R.)			
Oxford Furnace.................			
Bridgeville....................			
Manunka Chunk..............CL			
Delaware Bridge................	290	293	
Portland.......................	288	291	
Delaware Water Gap............	316	319	

Digitized by Google

STATIONS.	Above Tide.	Ocean Level.	Corrected.
Stroudsburg	400	403	
Sprague ville	487	490	
*Henryville	593	596	
*Oakland	1008	1011	
*Paradise	1518	1521	
Forks			
Tobyhanna (a)	1929	1932	
Gouldsboro.			
Summit	1887	1890	
*Moscow.	1555	1558	
*Dunning's	1397	1400	
Greenville	1182	1185	
Scranton.........CLVI, CXVIII	740	743	
Clark's Summit	1239	1242	
Abington	1055	1058	
Factoryville.	917	920	
Tunnel	963	966	
Nicholson	766	769	
Hopbottom.	890	893	
Foster			
Oakley's..	942	945	
Montrose Station	1050	1053	
New Milford	1084	1087	
Great Bend	876	879	
State Line	860	863	
Corbettsville	852	855	
Conklin	849	852	
Binghamton..............CLXII	843	846	

a The highest point noted on the profile, 1970 feet above tide. This point is between Tobyhanna & Summit.

* Elevations at stations marked thus (*) were not marked on the profile; neither could it be exactly determined what was the vertical scale of the profile; but it was supposed to be 290 feet to the inch.

The following list is therefore added, some of its figures corresponding exactly with those above. It was obtained from a profile in the office of the Pennsylvania Canal Co., at Harrisburg, made under the direction of J. Dutton Steele, in 1851.

STATIONS.	Above Tide.	Ocean Level.	
White House	170	173	
Lebanon	274	277	
Clinton	326	329	
New Hampton Summit	505	508	
West End Switch	498	501	
Delaware Bridge	293	296	
Delaware Water Gap	314	317	
Stroudsburg	422	425	
Naglesville	1961	1964	
Greenville	1182	1185	
Scranton	739	742	

Digitized by Google

CLVI. Bloomsburg Division, D. L. & W. R. R.

Elevations of the Bloomsburg Division of the Delaware, Lackawanna and Western R. R. were copied from notes, in the possession of Mr. A. Bryson, Jr., Div. Engineer, at Scranton, Pa. This list contains all the levels that could be obtained of this road.

STATIONS.	Mean Tide.	Ocean Level.	
Scranton CLV	740	743	
Taylorville......................	683	686	
Lackawanna Junction............	573	576	
Pittston........................	573	576	
West Pittston..................	580	583	
Wyoming	560	563	
Maltby........................	560	563	
Kingston......................	551	554	
Plymouth Junction..............	545	548	
Plymouth	539	542	
Avondale......................	534	537	
Nanticoke......................			
Hunlock's Creek................			
Schickshinny....................			
Beach Haven....................			
Berwick........................			
Brier Creek....................			
Espey..........................			
Bloomsburg			
Rupert........................			
Catawissa Bridge................			
Danville........................			
Northumberland................			
Sunbury........................			

CLVII. Lackawanna R. R.

Elevations on the Lackawanna R. R. between Carbondale and Scranton were furnished by Mr. A. H. Vaudling, Superintendent Delaware and Hudson Canal Co.'s R. R. at Providence, Luzerne County, Pa.

The datum is "Tide;" but whether high tide or mean tide is not known. Supposing it to be *mean* tide, 3.349 feet is added for Ocean Level.

STATIONS.	Above Tide.	Ocean Level.	
Carbondale (*a*)..............CLX	1083	1086	
Jermyn	968	971	
Archbald........................	965	968	
Olyphant........................	807	810	
Providence (*b*)..................	700	703	

a Coal Brooke Breaker in Carbondale. The *canal level* at Carbondale is given by J. D. Steele as 965; see Table CLVIII.

b Elevation at the Lackawanna.

Digitized by Google

CLVIII. Carbondale & Honesdale R. R.

Levels on the Carbondale and Honesdale Railroad are in accordance with a profile furnished by Mr. A. H. Vandling, Superintendent of the Delaware and Hudson Canal Company, office of coal department, at Providence Penna. According to the profile which is marked, "Profile B, New Road," the *loaded* track starts from Carbondale at a point marked 1012 feet above tide; and the *empty* track starts at a point marked Honesdale 1000 feet above tide. In J. D. Steele's list (CLVIII) Carbondale and Honesdale are both alike called 965′ above tide, at the level of the canal.

	STATIONS.	Above Carbondale.	Above Tide.	
Loaded cars, east-ward.	Carbondale, lower end......	00	1012	
	Head of Plane 1............	240	1252	
	Head of Plane 2............	377	1389	
	Head of Plane 3............	579	1591	
	Head of Plane 4............	762	1774	
	Head of Plane 5 (*a*)	923	*1935	
	Head of Plane 6............	906	1918	
	Head of Plane 7............	572	1584	
	Foot of Plane 7 (*b*)..........	440	1452	
Empty cars back.	Honesdale............ CLIX	00	1000	1003
	Head of Plane 1............	180	1180	1183
	Head of Plane 2............	178	1178	1181
	Head of Plane 3............	290	1290	1293
	Head of Plane 4............	424	1424	1427
	Head of Plane 5............	502	1502	1505

CLIX. Honesdale Branch Erie Railway.

STATIONS.	Above Tide.	Ocean Level.	
Honesdale................CLVIII	966		
White Mills....................	925		
Hawley	899		
Kimbles........................	849		
Millville	780		
Rowlands	700		
Lackawaxen	650		

CLX. Delaware and Hudson Canal.

This list is from J. Dutton Steele's profile of 1851, in Penna. Canal Co'.s office, at Harrisburg.

TOWNS.	Above Tide.	Ocean Level.	
Carbondale...............CLVII	965		
Honesdale......................	965		
Hawley.........................	880		
Port Jarvis....................	455		
Port Clinton...................	455		

a Summit.
b From this point to Honesdale, a distance of 10 miles, there is a regular descent of 44 feet to the mile.

Digitized by Google

CLXI. Jefferson Branch, Erie Railway.

STATIONS.	Above Tide.	Ocean Level.	
Lanesboro Junction (*a*)....CLXII	982		
Ninevah Junction...............	981		
Brandts.........................	1047		
Stevens Point...................	1078		
Webster's Mills	1297		
Starrucca	1424		
Thompson	1703		
Ararat Summit...................	2023		
Herrick Centre	1803		
Uniondale.......................	1693		
Forrest City....................	1481		
Carbondale	1079		

a With the Erie Railway at Lanesboro, in Susquehanna Co., Pa., about 190 miles from New York City. This road runs south to the Anthracite Coal field.

CLXII. Erie R. R. Line.

Levels on the Erie Railway were copied from profiles furnished by Mr. H. D. Blunden, Assistant Engineer. The profiles are complete, embracing the main line of road from Jersey City to Dunkirk, and all branches owned by the Erie Railway Company.

The datum is tide water at Jersey City. This, if *mean tide*, may be considered equivalent to Ocean Level.

Erie R. R.—Delaware Div.

STATIONS.	Above Tide.	Ocean Level.	
Port Jervis	440		
Pond Eddy	571		
Shoholo.........................	648		
Lackawaxen................CLX	648		
Pine Grove	668		
Narrowsburg.....................	714		
Nobodys	748		
Cohecton	748		
Callicoon	781		
Rock Run........................	787		
Hawkins.........................	809		
Basket	830		
Bouchon	850		
Lordville	864		
Stockport.......................	896		
Hancock.........................	926		
Dickinsons	954		
Hales Eddy......................	974		
Deposit	1009		
Summit..........................	1373		
Susquehanna..............CLXI	914		

Digitized by Google

Erie R. R.—Susquehanna Div.

Great Bend	884		
Binghamton ... CLV	868		
Hooper	839		
Union	834		
Campville	830		
Owego	822		
Tioga	805		
Smithboro	799		
Waverly	836		
Chemung	820		
Wellsboro	831		
Elmira	863		
Corning ... CLXIV	942		
Painted Post	947		
Erwins	983		
Addison	993		
Rathboneville	1015		
Cameron Mills	1029		
Cameron	1056		
Santees	1067		
Adrian	1112		
Canesteo	1134		
Hornellsville	1161		

Erie R. R.—Western Div.

Tip Top Summit	1783		
Andover	1676		
Genessee	1511		
Scio	1458		
Philipsville	1390		
Belvidere	1384		
Friendship	1539		
Cuba Summit	1698		
Cuba	1542		
White House	1514		
Hindsdale	1501		
Olean	1438		
Allegheny	1422		
Vandalia	1415		
Carrollton ... CLXVI	1399		
Great Valley	1393		
Salamanca	1384		
Little Valley	1594		
Cattaraugus	1411		
Persia	1390		
Smith's Mills	1010		
Forestville	883		
Dunkirk (*a*)	600		

a The elevation given at Dunkirk by Lake Shore and Michigan Southern R. R., is 24.94 + 573. L. Erie = 597.94.

Digitized by Google

CLXIII. *Erie R. R.—Buffalo Div.*

STATIONS.	Above Tide.	Ocean Level.	
Arkport	1199		
Burns	1203		
Canesceraga	1260		
Garwoods	1280		
Swains	1312		
Turnout	1319		
Nunda	1336		
Hunts	1339		
Portage	1314		
Castile	1401		
Gainesville	1407		
Warsaw	1326		
Dale	1178		
Linden	1181		
Attica	998		
Tonawanda	1003		
Summit	1086		
Griswold	1044		
Darien	1024		
Alden	868		
Town Line	742		
Lancaster	683		
Checktowga	661		
East Buffalo	611		
Buffalo	588		

CLXIV. *Corning, Cowanesque & Antrim Railway.*

The levels on Corning, Cowanesque and Antrim Railway, were furnished by Mr. A. H. Gorton, Supt. The levels on this road have been reduced to the datum of the New York and Erie Railway, by adding 26 feet to Mr. Gorton's figures.

STATIONS.	Tide.	Corrected Tide.	
Corning.....CLXII	*918	†942	
Ernin Centre	952	976	
Lindley	973	997	
Lawrenceville.....CLXV	982	1006	
Nelson	1162	1186	
Elkland	1118	1142	
Lawrenceville.....CLXV	982	1006	
Tioga Village	1028	1052	
Holliday	1127	1151	
Middleburg	1154	1178	
Niles Valley	1168	1192	
Wellsboro	1295	1319	
Summit	1838	1862	
Antrim Coal Mines	1648	1672	

* Grade at Corning Junction according to Mr. Gorton.

† Grade at Corning Junction by profile of Erie Railway.

Digitized by Google

CLXV. *Tioga R. R.*

Levels on the Tioga R. R. were furnished by Mr. S. B. Elliott, Engineer of the T. R. R.

The datum is asserted to be that of the Erie R R. at Corning: in other words the following figures have been constructed on the basis of the Erie R. R. list, without reference to Mr. Gorton's intermediate station levels.

STATIONS.		Above Tide.	Ocean Level.
Lawrenceville............CLXIV		1006	
Somer's Lane		1018	
Mitchell's Creek................		1022	
Old Station		1035	
Tioga..........................		1042	
Mill Creek		1077	
Lamb's Creek..................		1111	
Mansfield.......................		1140	
Canoe Camp....................		1163	
Covington......................		1208	
Blossburg......................		1348	
Morris Run (*a*).................		1678	
Arnot (*b*).......................		1682	
Fall Brook (*c*)..................		1842	

a, *b*, *c* Coal Mines in the Blossburg Basin.

CLXVI. *Bradford Branch, Erie Railway.*

STATIONS.	Above Tide.	Ocean Level.	
Carrollton Junction (*a*)....CLXII	1400		
Ernins Mills	1409		
Limestone......................	1415		
Babcock	1429		
Bradford	1464		
DeGolias	1510		
Big Shanty	1715		
Crawfords	2098		
Summit (*b*).....................	2140		
Alton	2080		
Gilesville.......................	2016		

a With the Erie R. R., 407 miles from New York. This road runs south to the coal fields of McKean Co., Pa.

b Highest point on the profile just south of Crawfords.

Digitized by Google

V. SUSQUEHANNA SERIES.

CC. Northern Central.

Levels on the N. C. R. R. were copied from an old lithographed profile in the office at Baltimore, Md.

Datum : Mean tide at Baltimore; equivalent to + Ocean level.

STATIONS.	Mean Tide.	Ocean Level.	
Baltimore			
B. & P. R. R. Junction			
Mount Vernon	131		
Green Spring Junction (*a*) CCLV			
Timonium	381		
Cockeysville			
Sparks			
Monkton			
Parkton	420		
Freelands	596		
New Freedom	827		
Seitzland	611		
Glen Rock	551		
Hanover Junction (*b*)	422		
Smysers	389		
Glatfelter's	335		
Tunnel	299		
York (*c*) CCVI, CCVII	366		
Emigsville	376		
Mount Wolf	376		
Summit, No. 2	466		
Conewago Bridge	289		
York Haven	291		
Goldsboro	304		
Middletown Ferry	307		
Marsh Run	307		
New Cumberland	312		
Bridgeport (*d*) CCIX	355		
Marysville	350		
Dauphin (*e*) LXIII			
Clark's Ferry	361		
Halifax	378		
Liverpool			
Mohontongo			
Millersburg (*f*) CCXI	396		
Georgetown	417		
Trevorton Junction (*g*) LXIX	428		
Fisher's Ferry	433		
Selinsgrove	438		
Sunbury (*h*) CCXV	444		

a With Green Spring Branch N. C. R. R.

b With Hanover Branch, Han. & Gett. R. R.

c Junction with Peach Bottom R. R. and with York and Columbia R. R., and York & Gettysburg R. R.

d Opposite Harrisburg. Junction with Cumberland Valley R. R.

Digitized by Google

A list of levels of some of the above named points made by J. D. Steele, in 1851, was obtained in the office of the Penna. Canal Co., at Harrisburg, and is given for comparison, as follows:

STATIONS.	Mean Tide.	Ocean Tide.	
Mellvale	168		
Timonium	395		
Ashland	269		
Monckton	344		
Parkton	430		
Summit	860		
Glenrock	556		
Glatfelter's	472		
York	373		
Conewago Creek	285		
Bridgeport	343		
Dauphin	332		
Halifax	360		
Lykens V. R. R. Junction	380		
Millersburg	382		
Georgetown	417		
Sunbury CCXV	429		

CCI. Tide Water and Susquehanna Canal.

Levels on the T. W. & S. Canal, were copied from a profile in the office of the Schuylkill Navigation Company, at Reading, Pa., by permission of Mr. James F. Smith, Chief Engineer.

Datum, *low tide* at Havre de Grace. Information on the spot leads to the belief that the tide rises here 2½ feet.

Tide Water Canal.

STATIONS.	Above Low Tide.	Ocean Level.	
Level of Chesapeake Bay	0		
Lock No. 9, surface of water	10		
Lock No. 8, " "	16		
Lock No. 7, " "	26.5		
Lock No. 6, " "	37		
Lock No. 5, " "	47		
Lock No. 4, " "	57		
Lock No. 3, " "	67		
Lock No. 2, " "	77		

e Junction with Schuylkill and Susquehanna R. R.

f Junction with Lykens Valley Coal R. R. (Summit Branch R. R.)

g With Mahanoy and Shamokin Branch P. & Reading R. R.

h Junction 1. With Shamokin Division R. R. (CCXIV). 2. With Danville Hazleton and Wilkesbarre R. R. (CXVII). 3. With Philadelphia & Erie R. R. (CCXV). Note. The cars of the Northern Central run on the P. & E. R. R. to Williamsport, and then on the leased line from Williamsport to Canandaigua, once called the Williamsport and Elmira R. R., and now known as the northern extension of he Northern Central R. R.

Digitized by Google

Susquehanna Canal.

Lock No. 19, (next to No. 2, T. W. C)	85		
Lock No. 18, upper level........	93		
Lock No. 17, " "	103		
Lock No. 16, " "	114		
Lock No. 15, " "	123		
Lock No. 24, " "	125		
Lock No. 23, " "	134		
Lock No. 22, " "	143		
Lock No. 22, " "	152		
Lock No. 20, " "	161		
Lock No. 9, " "	170		
Lock No. 8, " "	177.5		
Lock No. 7, " "	185		
Lock No. 6, " "	193		
Lock No. 5, " "	201		
Lock No. 4, " "	209		
Lock No. 3, " "	217		
Lock No. 2, " "	225		
Lock No. 1, " "	233		
Aqueduct across Cabin Branch Creek....................	233		
Grand Lock at Wrightsville, opposite Columbia...............	233		

CCII. Pennsylvania Canal, E. D.

Elevations on the Pennsylvania Canal, Eastern Division, were furnished by Mr. Thos. T. Wierman, Jr.

Datum is *mean tide*, Chesapeake Bay.

STATIONS.	Mean Tide.		
Columbia Dam, surface..........	221		
Canal Basin, (Columbia).........	236		
Susquehanna River below Conewago Falls..................	244		
Susquehanna River above Conewago Falls..................	263		
Harrisburg Canal Basin (*a*)......	312		
Clark's Ferry Dam	333		

a Surface of water in the large (Porter's) Basin at Harrisburg....... 320
Floor of vestibule of the State Capitol at Harrisburg................. 361

CCIII. Juniata Division Pennsylvania Canal.

Juniata River, Mouth :—			
Mitre Sill of Stop Lock at Junction.................. CCIV	347		
Millerstown dam, surface........	376		
Lewistown dam, "	442		
Canal at Lewistown "	450		
Anghwick dam, "	492		
Canal at Huntingdon "	586		
Huntingdon :			
Lower Mitre Sill of Lock No. 40	599		

Digitized by Google

CCIV. West Branch Division Pennsylvania Canal.

Juniata River, Mouth :—(*b*)			
Mitre Sill of Stop Lock at Junction..................CCIII	347		
Liverpool, water in River	368		
Liverpool, water in Canal	381		
Water in			
River below Shamokin dam ...	411		
Shamokin dam, at Sunbury....	419		
Canal at Northumberland..CCV	432		
Lewisburg dam (*c*)............	424		
Canal opposite Lewisburg......	445		
Muncy dam	459		
Loyalsoch dam and Canal......	502		
Canal at Williamsport	509		
Lock Haven dam..............	540		
Queens Run dam..............	546		
Bald Eagle dam...............	559		

b Surface of water of Pool of dam at Duncan's Island.............332

c This dam has no connection with the Canal, and is therefore at a lower level.

CCV. Wyoming Division Pennsylvania Canal.

Northumberland; canal levelCCIV	432		
Bench Mark at Northumberland..	434		
Danville ; canal level	443		
Bloomsburg ; canal level........	470		
Below Berwick ; canal level	480		
Shickshinny ; canal level........	500		
Nanticoke dam	504		
Wilkesbarre ; canal level........	534		
Water in river above Wilkesbarre	511		
Top of coping Plainsville Lock...	541		

CCVI. Peach Bottom R. R.

Levels of the Peach Bottom R. R. were copied from notes in the office at York.

Datum: Susquehanna River at Peach Bottom, on the assumption that the water in the river at Peach Bottom stood at 85.88 feet above tide.

According to the profile of the Frederick Division of the Pa. R. R., the elevation of York above tide at Baltimore, is 364.6 feet. This is the latest determination. Sixteen feet have therefore been substracted to make the second column.

This R. R. is a 3 foot or "Narrow Guage," and connects with the Northern Central R. R. at York.

Digitized by Google

STATIONS.	Assumed Datum.	Corrected Tide.	
Susquehanna River Water	(85.88)	(70)	
Peach Bottom (*a*)	92.27	76	
Bangor Summit	511.23	495	
Delta	435.37	419	
Bryansville	241.36	225	
Woodbine	294.21	278	
Bridgeton	304.89	289	
Bruce	331.50	315	
Muddy Creek	366.86	351	
High Rock	382.93	367	
Laurel	411.62	395	
Fenmore	434.64	418	
Brogueville	478.19	462	
Felton	536.46	520	
Windsor	598.8	583	
Springvale	734.4	718	
Red Lion	912.91	896	
Dallastown	657.00	641	
Ore Valley	570.32	554	
Enterprise	531.20	515	
Smalls Mills	433.75	418	
Springgarden	431.53	415	
York ....CC,, IV CCVII	381.24	365	

a There is a Peach Bottom R. R. in Lancaster Co., branching from the Philadelphia and Baltimore Central, at Oxford, (see table CCLII,) and intended to connect with this line of York Co. at Peach Bottom, on the Susquehanna River.

CCVII. Pennsylvania Railroad, Frederick Division.

Levels of the Frederick Division, Pa. R. R., were copied from a profile of the road, in the office of the Pa. R. R. at Philadelphia, by permission of Mr. W. H. Brown, Engineer for Maintenance of Way.

Datum: Mean tide at Baltimore.

STATIONS.	Mean Tide.	Ocean Level.	
York (*a*) ....IV, CC	365		
Codorus Creek	357		
Graybills	426		
Bairs	452		
Spring Forge	455		
Menges Mill	455		
Iron Bridge	496		
Jacobs Mill	504		
R. R. Crossing (*b*)	607		
Hanover	599		
Conewago Bridge	546		
Littlestown	619		
Bridge	623		

a Junction with Northern Central; with York Branch of Columbia R. R.; and with Peach Bottom.

b Hanover Junction and Gettysburg R. R. Crosses at grade.

Digitized by Google

STATIONS.	Mean Tide.	Ocean Level.	
State Line	540		
Piney Creek	505		
Galts	486		
Taneytown	493		
R. R. Crossing (*c*)........CCLV	426		
Ladiesburg	464		
New Midway	458		
Woodsborough	400		
Georgetown	290		
Ritters	301		
Harmony Grove	310		
Frederick	280 (?)		
B. & O. Junction (*d*).....CCLVI	375		

c Western Maryland R. R., but *not at grade*.
d Connection with Baltimore and Ohio R. R.

CCVIII. Cumberland Valley R. R.

Levels on the Cumberland Valley R. R., were furnished by Mr. J. B. Dougherty, Engineer of the road at Chambersburg.

Datum: Originally a point on the Penna. R. R. at Harrisburg, foot of Market street, 315 feet above high water at Philadelphia.

STATIONS.	High Tide.	Ocean Level.	
Harrisburg (*a*).............I, CC	315	322	
Susq. Bridge, (west end) (*b*)	350	357	
Shirmanstown			
Mechanicsburg	429	436	
Dillsburg Junction (*c*)......CCIX	420	427	
Kingston			
Middlesex			
South Mountain Junction (*d*)	451	458	
Carlisle	470	477	
Greason's			
Newville	526	533	
Oakville			
Shippensburg	647	654	
Summit (*e*)	776	783	
Scotland			
Mount Alto Junction (*f*)	707	714	
Chambersburg	611	618	
Marion			
South Pennsylvania Junction (*g*)	625	632	
Greencastle	578	585	
State Line			
Hagerstown	565	572	
Falling Waters			
Potomac Bridge	369	376	
Beddington			
Martinsburg (*h*) CCLVI	457	634	

a Junction with Penna. R. R., and with Northern Central R. R.
b Bridgeport. *c* Dillsburg Junction. *d* South Mountain R. R. Junction.
e Mount Alto R. R. Junction. *f* Southern Penna. R. R. Junction.
g Junction with Baltimore and Ohio R. R.

Digitized by Google

CCIX. Mechanicsburg and Dillsburg R. R.

Levels on the Mechanicsburg and Dillsburg R. R. were copied from notes in possession of Mr. J. B. Dougherty, Assistant Engineer on the Cumberland Valley R. R., at Chambersburg, Pa.

Datum: That of the Pa. R. R., high tide at Philada.

STATIONS.	High Tide.	Ocean Level.	
Mechanicsburg Junc. (*a*) CCVIII	420	427	
Dillsburg	536	542	

a With Cumberland Valley R. R. at Mechanicsburg, 8.5 miles west of Harrisburg.

CCIX bis. South Mountain R. R.

No levels of this road could be obtained. It runs south from Carlisle by Papertown, to Pinegrove Furnace, on Mountain Creek in the South Mountains.

STATIONS.			
Carlisle Junction (*a*) CCVIII			
Bonny Brook			
Craigh Head's			
Mount Holly Springs			
Upper (Paper) Mill			
Hunter's Run			
Henry Clay			
Laurel			
Pinegrove (Furnace)			

CCX. Mount Alto R. R.

Levels on the Mount Alto R. R., were furnished by Mr. George B. Wiestling, Engineer and Superintendent.

Datum is "Elevation of Rail at foot of Market street, Harrisburg, 315.2 above high tide in Schuylkill River at Philadelphia."

This road runs to Mount Alto Furnace at the west foot of the South Mountain.

STATIONS.	High Tide.	Ocean Level.	
C. V. R. R. Junction (*a*)	705	712	
Summit (*b*)	732	739	
Brookside (*c*)	700	707	
Woodstock (*d*)	708	715	
Chambersburg Turnpike (*e*)	740	747	
Reno Ore Bank	875	882	
Mount Alto (*f*)	961	968	

a Junction with Cumberland Valley R. R., near Chambersburg.
b Between C. V. R. R. and Conochocheague Creek.
c At crossing of Creek.
d At crossing of Creek.
e Chambersburg and Gettysburg Turnpike,
f Near the Furnace.

Digitized by Google

CCX *bis.* *Southern Pennsylvania R. R.*

No levels could be obtained.

STATIONS.		Ocean Level.	
C. V. R. R. Junction (*a*) CCVIII			
Williamson....................			
Lehmaster's....................			
Mercersburg Junction............			
Loudon........................			
Richmond			
Mercersburg terminus			

a One mile south of Marion, and seven miles south of Chambersburg.

CCXI. *Summit Branch R. R.*

Levels of the Summit Branch R. R., were furnished by Mr. W. E. Ray, Supt. of the R. R., and cannot be relied upon as being entirely correct; but it is the only record which could be found of the road.

This road is called also the Lyken's Valley R. R.

Datum: Mean tide at Baltimore.

STATIONS.	Mean Tide.	Ocean Level.	
Millersburg (*a*).................	395		
Elizabethville..................			
Cross Road.....................	660		
Lykenstown.....................	675		
Wiconisco..................			
Big Lick Colliery...............			
Williamstown (*b*)...............	1125		

a On the Susquehanna River, east side; junction with Northern Central Railroad.

b Summit Branch Colliery. Connection broken for several miles with the Railroad from Brookside, past Good Spring, to Tremont and Pottsville.

CCXII. *Selinsgrove and N. B. R. R.*

Elevations on the line of the Selinsgrove and North Branch R. R. and of the Mifflintown Branch, of the same, were copied from notes in possession of Mr. W. A. Meeker, at Selinsgrove, Pa.

Datum assumed at a point on the D. L. & W. R. R. at Northumberland.

The second column gives the correlative heights above mean tide (Ocean level?) at Baltimore.

NOTE. This R. R. has never been built. Only the preliminary line levels at the points named are given in the following table.

The line starts in Northumberland at the terminus of the Bloomsburg Division of the Delaware, Lackawanna & Western R. R., crosses the mouth of the West Branch Susquehanna, and keeps down the right bank of the Susquehanna River, to the mouth of the Juniata River (Table CCXII).

Digitized by Google

The other branch of the line strikes across country from Selinsgrove to the Juniata River at Mifflintown (Table CCXIII).

STATIONS.	Assumed Elevation.	Mean Tide.	Ocean Level.
Northumberland (*a*)..CLVCCXV	100	439	
River Road (*b*)	86.4	426	
Keensville	84.9	424	
Selinsgrove (*c*)	88.7	428	
Burns dwelling house	67.9	407	
Pa. Canal (*d*)	70.6	410	
B. M., No. 16 (*e*)	74.7	414	
Port Trevorton R. R. Track	75.9	415	
Herrold's Saw Mill	63.3	403	
B. M., No. 18 (*f*)	72.6	402	
Wentzels Station	66.3	406	
McKee's Half Falls	63.1	402	
Rines Store	60.2	400	
B. M., No. 21 (*g*)	60.6	400	
Mahontonga Creek (*h*)	38.2	378	
B. M., No. 23 (*i*)	61.5	401	
B. M., No. 24 (*j*)	54.9	385	
B. M., No. 25 (*k*)	50.9	390	
Liverpool (*l*)	57.3	397	
Blattenberger's Mill	34.8	374	
Blattenberger's Creek (*m*)	16.4	356	
B. M., No. 27 (*n*)	31.4	371	
Montgomery's Creek (*o*)	14.5	354	
Girty's Notch Hotel	26.2	366	
B. M., No. 28 (*p*)	19.1	358	
New Buffalo (*q*)	24.6	364	
Buffalo Creek (*r*)	8.5	348	
B. M., No. 31 (*s*)	18	357	
Pittsburg Turnpike Crossing	15.2	355	
B. M., No. 33 (*t*)	—1.8	338	
Juniata River	-11.6	328	
Juniata Canal (*u*)	18.4	358	
Pa. R. R. (*v*)	23.5	363	
B. M., No. 34 (*w*)	19.6	359	

a Intersection with D. L. & W. R. R., at Northumberland.

b Opposite Northumberland.

c Centre of Pine Street.

d Top of mason work abutment of aqueduct, 2½ miles below Selinsgrove, crossing Penns Creek.

e Spike driven in telegraph pole, just above Port Trevorton.

f Below Port Trevorton, near two dwelling houses, on root of apple tree, 300′ from canal.

g 1500′ south of Benneville Kramer's house, on root of wild cherry tree.

h Surface of water, ordinary stage.

i 900′ north of Hoover's hotel, on chestnut tree.

j 2000′ south of "Dry Saw Mill" Hotel, piece of horse shoe, driven in telegraph pole.

k 500′ south of McCormick's barn, on root of elm tree.

l Centre of Market street.

m Surface of water.

n 900′ north of stone hotel, on root of black walnut tree.

Digitized by Google

CCXIII. Mifflintown Branch S. & N. Br. R. R.

NOTE. See last table CCXII.

STATIONS.	Assumed Elevation.	Mean Tide.	Ocean Level.
B. M., No. 1 (*a*)..........CCXII	101.2	441	
Kautz P. O. (*b*)	95.5	435	
Millers Mill....................	134.4	474	
Freeburg......................	157.2	497	
Apple's Brick House	205.8	545	
Road (*c*)........................	263	602	
Cross Creek	286.5	626	
B. M., No. 13 (*d*)................	375	714	
Shelly's Saw Mill (*e*)............	451.4	791	
Shelly's Summit................	453.2	793	
Richfield	412.6	752	
B. M., No. 14 (*f*)...............	408.7	748	
Cherryhill School House (*g*)	366.8	706	
Evansdale Summit..............	399	738	
Haldeman's Store (*h*)............	377.4	717	
Bunkertown Church (*i*)	350.3	690	
Bunkertown	354.3	694	
Little Lost Creek (*j*)............	355.4	695	
McAlistersville..................	308.6	648	
Leonard s Barn..................	262.9	602	
Wilson's Mill....................	227.2	566	
Wilson's Store..................	219.5	559	
Main Road (*k*)..................	224	563	
Banks Summit	270.6	610	
Happy Hollow School House (*l*)..	160.5	500	
Daniel Seiber's (*m*)..............	137.3	477	
Terminus of Line (*n*)..........I	109.2	449	

a Top of mile post No. 7, S. & L. R. R.
b Waters edge, ordinary low water, Middle Creek.
c Leading from Middleburg to Tremont.
d 1300′ west of Brick School House, root of white oak tree.
e Waters edge, head of Shelly's saw mill pond.
f Near rivulet.
g Public road crossing.
h Public road from Evansburg to Foutz Valley, opposite Haldeman's store.
i In public road, near Bunkertown Church.
j Surface of water.
k In main road, from McAlistersville to Mifflintown, one mile west of Oakland mills.
l Surface of water, creek or run, west of Happy Hollow school house.
m Surface of water in creek, at D. Seibers.
n Mifflintown, on large peg, with nail driven near corner of stable, at fence post.

o Surface of water.
p Point of rocks, foot of Girty's Mountain, spike driven in telegraph pole.
q Water in mill race.
r Surface of water.
s 700′ south of J. Steel's dwelling house, on root of black walnut tree.
t 600′ south of Pittsburgh turnpike crossing, on root of hickory tree, on river bank.
u On towing path, Juniata Canal.
v On cross tie, Pa. R. R., near Duncannon.
w On top of locust stump, at edge of embankment of Pa. R. R.

Digitized by Google

CCXIV. *Shamokin Branch N. C. R. R.*

The elevations on Shamokin Branch of the Northern Central R. R., were furnished by Mr. A. B. Starr, Assistant Engineer P. & E. R. R.
Datum: Mean tide, Baltimore.

STATIONS.	Above Tide.	Ocean Level.	
Sunbury Junction (*a*)........CC	442		
Snydertown....................	497		
Shamokin......................	738		
Lancaster Branch (*b*)	831		
Mount Carmel..................	1054		
End of Road................ ...	1090		

a Junction with N. C. R. W., at Sunbury.
b Junction with Lancaster Branch.

CCXV. *Philadelphia and Erie R. R.*

The levels on the Philadelphia and Erie R. R. were copied from the notes in the office of the Company at Williamsport, Pa., by permission of Mr. A. B. Starr, Assistant Engineer. These levels were made subsequent to 1862. It is intended to re-level the road in 1876, for no reliance is placed on the levels in this Table by the Engineers of the road.
Datum: Mean Tide at Baltimore.

STATIONS.	Mean Tide.	Corrected Levels.	
Sunbury (*a*)..................CC	428.30		
D.H. & W.R.R. Junc. (*b*).CXVII	436.10		
Northumberland (*c*)........CLV	439.30		
Montandon (*d*)..............XIII	446.60		
Catawissa R.R. Crossing (*e*)..LXV	454.50		
Milton..........................	458.30		
Watsontown....................	465.62		
Dewart.........................	470.40		
Catawissa R.R. Crossing (*f*) LXV	473.82		
Montgomery....................	474.10		
Muncy..........................	502.75		
Catawissa R.R. Crossing (*g*)..LXV	514.42		
Williamsport....................	510.43		
W. & E. (N. C.) Railroad Junction (*h*)...........CCXVII	516.02		
Newberry......................	513.20		
Linden.........................	517.21		

a Junction of Shamokin Branch of the Northern Central R. R.
b Junction Danville, Hazleton and Wilkesbarre R. R.
c Junction of Delaware, L. & W. R. R.
d Junction of Lewisburg, Centre & Spruce Creek R. R.
e Crossing of Catawissa R. R. near Milton.
f Crossing Catawissa R. R. near Montgomery.
g Crossing Catawissa R. R. below Williamsport.
h Junction with Northern Central R. W. near Williamsport.

Digitized by Google

STATIONS.	Mean Tide.	Corrected Levels.	
Susquehanna....................	516.60		
Jersey Shore....................	*577.07		
Pine........................	554.11		
Wayne........................	554.34		
Lock Haven (i)...............XV	†538.91		
Queen's Run....................	565.05		
Farrandsville....................	564.63		
Ferney........................	576.44		
Glen Union....................	587		
Whetham	600.80		
Ritchie........................	614.34		
Hyner	626.30		
North Point....................	641.02		
Renova........................	653.90		
Westport........................	672.64		
Cook's Run....................	691.43		
Keating........................	700.90		
Wistar........................	720.72		
Round Island....................	736.81		
Grove........................	754.40		
Sinnemahoning....................	775.71		
Bennett's Br. Extension (j) CCCII	795		
Driftwood....................	797.75		
Huntley........................	842.93		
Sterling........................	896.38		
Cameron........................	943.73		
B. N. Y. & P. R.R. (k) CCXVIX	1003.09	(1024)	
Emporium....................	1014.99		
West Creek....................	1091.75		
Beechwood....................	1225.66		
Rathbon........................	1299.18		
Hemlock........................	1446.05		
West Creek Summit..............	1677.64		
St. Mary's....................	1649.50		
Scahonda....................	1503.90		
Daguschahonda (l)..............	1461.95		
Shawmut (m)....................	1408.56		
Ridgway........................	1375.73		
Johnsonburg....................	1423.52		
Wilmarth	1428.80		
Wilcox........................	1508.52		
Dahoga........................	1586.75		
Clarion Summit..................	2007.90		
Kane........................	2002.83		
Wetmore........................	1792.63		
Ludlow........................	1591.55		
Roy Stone....................	1403.75		

* Probably 557.07. † 558.91 ? See next Table below. See also the 555 of Table XV.
i Junction with Bald Eagle Valley R. R.
j Junction with the Bennett's Branch Extension of Allegheny Valley R. R.
k Junction with the Buffalo, New York & Philadelphia R. R.
l Here the Daguchahonda R. R. joins. No levels got.
m Shawmut R. R. No levels got.

Digitized by Google

STATIONS.	Mean Tide.	Corrected Levels.	
Sheffield	1325.70		
Tiona	1348.03		
Clarenden	1385.46		
Stoneham	1335.93		
Warren ... CCCVI	1182.60		
Oil Creek & A. V. R. R. Crossing ... CCCIV	1158.80		
Irvineton	1156.60		
Youngsville	1199.85		
Pittsfield	1233.31		
Garland	1297.47		
Spring Creek	1383.85		
Columbus	1389.18		
B.C.&P.R.R. Crossing (*l*) CCCIX	1429.20		
Corry	1419.58		
A.& G.W.R.R. Crossing (*m*) CCC	1415.92	(1439)‡	
Lovell's	1362.90		
Concord	1373.80		
Union	1258.63		
Lebeuff	1207.20		
Waterford	1181.72		
Jackson's	1218.70		
Langdon's	1123.52		
Belle Valley	995.96		
L. S. & M. S. Railroad Crossing (*n*) ... CCCLXXXIII	675.64		
Erie Depot ... CCCLXXXIV	(573)		
Lake Erie, Water	(565)	(573)‖	

l Crossing of the Buffalo, Corry and Pittsburgh R. R.
m Crossing of the Atlantic & Great Western R. R.
n Junction with the Lake Shore and Michigan Central at Erie.
‡ Level by the N. Y. & E. R. R.
‖ Accepted level of Lake Erie.

NOTE.—In the following Table some levels according to a profile made by John F. Burgin, Civil and Topographical Engineer, in 1862, are compared with levels of the same points found in Table CCXV above.

Column 1 shows Mr. Burgin's figures.

Column 2 shows the office figures.

STATIONS.	Above Tide.	Above Tide.	Difference.
Sunbury	423	428	+ 5
Milton	451	458	+ 7
Williamsport	506	510	+ 4
Lock Haven (*a*)	552	539	+ 7
De Crano	716		
2d Fork Sinnamahoning	787	798 ?	+11
Emporium	1011	1015	+ 4
Foot of Maximum Grade	1330		

a The 539 must be an error for 559.

Digitized by Google

STATIONS.	Above Tide.	Above Tide.	Difference.
West Creek Summit.............	1682	1678	— 4
St. Mary's (*b*)....................	1628	1649	+21
Foot of Maximum Grade........	1518		
Ridgway (*c*)....................	1387	1376	— 9
Johnsonburg....................	1429	1424	— 5
Wilcox..........................	1501	1509	+ 8
Foot of Maximum Grade.........	1525		
Clarion Summit...............	2006		
Head of Two Mile Run..........	1914		
Foot of Maximum Grade.........	1456		
Sheffield.........................	1324	1326	+ 2
Dutchman's Summit.............	1393		
Warren...........................	1189	1183	— 6
Irvine...........................	1162	1157	— 5
Youngsville.....................	1203	1200	— 3
Pittsfield........................	1236	1233	— 3
Garland..........................	1298	1297	— 1
Spring Creek Station...........	1381	1384	+ 3
Columbus.......................	1388	1389	+ 1
Corry............................	1416	1420	+ 4
Logan's Summit...............	1429		
Lovell's..........................	1363	1363	0
Concord.........................	1372	1374	+ 2
Union............................	1259	1259	0
Le Boeuf.........................	1205	1207	+ 2
Waterford.......................	1181	1182	+ 1
Jackson.........................	1218	1219	+ 1
Langdon's.......................	1123	1124	+ 1
Belle Valley.....................	994	996	+ 2
Erie Depot.......................	573		
Lake Erie Surface (*d*)...........	565		

b Difference of 21 feet probably to be accounted for on the supposition that two different points are indicated, the gradients here being very steep.

c Head of the Clarion River, at the forks.

d The level of Lake Erie water was fixed by J. T. Gardner's Tables (U. S. Geol. and Geographical Survey of Colorado, for 1873, p. 635) "mean of observations from 1844 to 1857, 573.08;" adopted result at Cleveland, dependent upon repeated Erie Canal Levels and U. S. Coast Survey work.

CCXVI. Muncy Creek R. R.

The levels on the Muncy Creek R. R. were furnished by Mr. B. Morris Ellis, Treasurer.

Datum: Catawissa; (Reading) R. R. Mid tide at Philadelphia. Add 8 feet, for Ocean Level.

This R. R. line runs northeast, up Muncy creek to the top of the Allegheny or Great North Mountain table land of Sullivan County.

Digitized by Google

STATIONS.	Mean Tide.	Corrected Tide.	
Hall's Station (*a*) LXV	410	510	
*Hughesville (*b*)................	483	583	
Picture Rock.....................	551	651	
Tivola..........................	591	691	
Muncy Bottoms...................	675	775	
Sonestown.......................	829	929	
McNeal's Summit (*c*)............	1676	1776	

a On Catawissa R. R. east bank of River.

b Mr. B. Morris Ellis, says, "This station is 80 feet higher than the Muncy Station (west side of river) on P. & E. R. R." called in Table CCXV, 502.75, and therefore, Hughesville is 582.75. Accordingly 100′ is added to Mr. Ellis' 483, and therefore to all other figures in the first column to make the second.

c This is the dividing ridge, between the Loyalsock and Muncy Creeks, which head within one-fourth mile of each other. It is known as McNeal's Summit, an engineer of that name having established a "bench" at this point many years since. It is two miles south of the town of Laporte (B. Morris Ellis).

Elevations of points in Sullivan County, Pa., furnished by Mr. B. Morris Ellis, of Hughesville, Pa.

In Cully township, in front of the hotel, at Long Pond, it is 2235′ above tide.

On the turnpike, one mile west of Long Pond, 2285′, the highest *known* point in Sullivan County.

At Lewis Lake, or Eagles Meare, it is 1726′.

CCXVII. Williamsport and Elmira R. R.

(NOW NORTHERN CENTRAL.)

Levels on this Northern Division of the Northern Central R. R. from Williamsport to Canandaigua, were copied from a profile in the office of the Company at Elmira. This road runs north up Lycoming creek.

Datum: Mean tide at Baltimore, Md.

STATIONS.	Mean Tide.	Ocean Level.	
Williamsport (*a*)..........CCXV	540		
Cogan Valley....................			
Crescent........................			
Trout Run.......................			
Bodine's........................			
Ralston.........................	860		
Roaring Branch..................			
Carpenter's.....................	1200		
Canton..........................	1250		
Minnequa........................	1230		
Alba............................			
West Granville..................			
Granville Summit................	1393		

a Junction with Philadelphia and Erie R. R.

Digitized by Google

STATIONS.	Mean Tide.	Ocean Level.	
Troy	1100		
Columbia Cross Roads			
Snedeker's			
Gillett's			
New York State Line			
Elmira (*b*) CLXII	865		
Horse Heads			
Pine Valley			
Mill Port			
Croton			
Havana	400		
Watkin's			
Rock Stream			
Starkey			
Himrod's			
Milo			
Pennyan			
Benton			
Hall's			
Stanley (*c*)			
Hopewell			
Canandaigua (*d*)	1070		

b Crosses New York and Erie R. R.
c Junction with Ontario and Southern R. R.
d Connects with New York Central and H. R. R. and Canandaigua and Tonawanda R. R.

CCXVIII. Jersey Shore, Pine Creek, and Buffalo R. R.

Levels on the J. S., P. Cr., and Buffalo R. R. were furnished by Mr. John S. Ross, Auditor. Datum: "Atlantic Ocean." This road is not yet built.

STATIONS.	Ocean Level.		
Williamsport, City limit (*a*) CCXV	502		
Linden (Surface of Canal)	501		
Larry's Creek (on Plank Road)	514		
Jersey Shore (Main Street)	521		
Pine Creek Crossing (Lentz)	532		
" " (Ramsey's Bend)	558		
Waterville (Surface Little Pine Cr)	587		
Jersey Mills	626		
Campbelltown	673		
Pine Cr. Crossing (near Slate Run)	709		
" " " Cedar "	760		
Babb's Creek Road	833		
Pine Cr. Crossing (ab. Marsh Cr.)	1106		
Gaines' (Water, Pine Creek)	1219		
Kilbourne's (Water, Pine Creek)	1274		
Grade at Summit of Tunnel	2202		
Coudersport	1634		
Roulette	1510		
Port Allegheny (*b*) CCXIX	1454		

a The Canal level at Williamsport, however is 509 according to Table CCIII.
b On Buffalo, N. Y. & Phila. R. R.—The difference between the Tables 1479—1454 = 25′ is unexplained.

Digitized by Google

CCXIX. *Buffalo, New York and Philadelphia R. R.*

Elevations on the B. N. Y. and P. R. R. were furnished by Mr. Geo. S. Gatchell, Engineer, who writes: "Calling Lake Erie 573′ above tide, *our* elevation at the crossing of the Erie Railway, at Olean, is 1435. Erie (R. R. levels) 1438, difference 3′. At Buffalo our elevation is 11′ above what we took to be surface of water in Lake Erie, but I do not think it is exactly right. We assumed surface of water in Lake Erie from surface of water in Buffalo Creek, about 3 miles from the Lake. Lake Erie, 573′; our depot, 11′ = 584; Erie Railway (levels) 588; difference 4′. You see the difference at Olean & Buffalo is very near the same. The Erie Railway here (at Olean), is on about the same elevation as our track."

STATIONS.	+Lake Erie	Above Tide	Erie R. R. Correction.
Emporium (*a*).....CCXV	448	1021	1024
Shippen..................	630	1203	1206
Keating (Summit)........	1305	1878	1881
Liberty..................	1070	1643	1646
Port Allegheny	906	1479	1482
Larabee's................	905	1478	1481
Eldred...................	867	1440	1443
State Line...............	867	1440	1443
Portville................	866	1439	1442
Olean (*b*).........CLXII	862	1435	1438
Hindsdale................	880	1453	1456
Ischua...................	965	1538	1541
Franklinville............	1017	1590	1593
Machias	1080	1653	1656
Yorkshire................	882	1455	1458
Arcade...................	881	1454	1457
Protection...............	807	1380	1383
Holland..................	600	1173	1176
South Wales..............	414	987	991
Aurora...................	348	921	925
Jamieson.................	317	890	894
Elma.....................	250	823	827
Spring Brook.............	180	753	757
Ebenezer.................	63	636	640
Buffalo (*c*)............	11	584	588*

a On the Philadelphia and Erie R. R. where the unreliable list of the P. & E. R. R. makes the elevation 1003.09.

b Crosses New York & Erie R. R.

c Uses the same depot with the N. Y. & E. R. R., Lake Shore & M. S. R. R.

———. *Daguschahonda R. R.*

CCXX. *McKean and Buffalo R. R.*

Elevations on the McKean and Buffalo R. R. were furnished by Mr. S. V. Godden, Superintendent.

Datum: Lake Erie. To which must be added 573′ to reduce to Ocean Level.

The first column gives heights above an originally assumed Lake level. The second column corrects these heights for true Lake level.

Digitized by Google

STATIONS.	Above Lake Erie.	Above Lake Erie.	Above Tide.	
Buff. N. Y. & P. R. R. (*a*) CCXIX	873.00	896.50	1469	
Larabee's................	871.50	895	1468	
Frisbee..................	860.50	884	1457	
Farmer's Valley..........	871.50	895	1468	
Smethport................	889.06	913	1486	
Crosby...................	936.30	960	1533	
Colegrove................	938.80	962.30	1535	
Hamlin...................	953.00	976.50	1549	
Wernwag..................	1256.50	1280	1753	
Clermont (*b*)............	1469.50	1493	2066	

a Junction with the Buffalo, New York and Philadelphia R. R. near Larabee's Station, on the Upper Alleghany River. *b* Bishop's Summit.

VI. SOUTHERN SERIES.

CCL. West Chester and Philadelphia R. R.

The levels of the West Chester and Philadelphia R. R., were copied from the profile, by permission of Mr. Thos. H. Hall, Treasurer of the Company.

Datum: Ordinary *low* water at Philadelphia. This is about the same as Ocean Level.

STATIONS.	Above Tide.	Ocean Level.	
Philad'a Depot, 31st & Chestnut st	14	14	
Woodland Street................	57	57	
Angora.........................	74.5	74.5	
Fernwood.......................	90	90	
Darby Road.....................	103	103	
Kelleyville....................	102	102	
Clifton........................	109	109	
Springhill.....................	128	128	
Morton.........................	121.5	121.5	
Swarthmore.....................	125	125	
Wallingford....................	168	168	
Manchester.....................	211.5	211.5	
Media..........................	210	210	
Greenwood......................	218	218	
Glen Riddle....................	160	160	
Lenni..........................	136	136	
West Chester Junction (*a*) CCLII	133	133	
Darlington.....................	143	143	
Glen Mill......................	199	199	
Cheney.........................	240	240	
Street Road....................	252	252	
Hemphill.......................	318	318	
West Chester...................	406	406	

a With Philadelphia and Baltimore Central R. R.

Digitized by Google

CCLI. West Chester R. R.

Elevations of points on the West Chester Railroad, were copied from a profile made in 1831, in possession of Mr. Thos H. Hall, Treasurer, at the office of the Company, in Philadelphia. There is no location of the present stations on the profile, therefore the elevations in the following list, are given at the points where marked on the profile.

Datum: "Tide;" but a correction of 21 was needful; see note *b*; add 7 feet for Ocean level below P. R. R. datum.

STATIONS.	"Tide."	Corrected Tide.	Ocean Level.
West Chester			
Liberty Grove (*a*)	475.6	455	462
Goshen Street	474.6	454	461
Jones Hill	540	519	526
Ship Road	471	550	557
Steamboat Road	599.50	579	586
Summit	607.33	587	594
Malvern Junction P. R. R. (*b*)..I	560	539	546

a The starting point of the road in the *eastern* part of the town of West Chester.

b Junction with Pennsylvania R. R. at Malvern Station. The elevation of the Pa. R. R. at this point is + 539.258. The levels on West Chester Railroad have been reduced to correspond with Pa. R. R.

CCLII. Philadelphia and Baltimore Central R. R.

Levels on the Philadelphia and Baltimore Central Railroad, were copied from a profile furnished by Mr. H. Wood, Gen'l Supt.

Datum is said to be *mid tide* at Philadelphia = about Ocean level.

STATIONS.	Above Tide.	Ocean Level.	
Lamokin Junction CCLIII			
Rockdale			
Lenni			
West Chester Junction (*a*)..CCLI	133	133	
Chester Heights	234	234	
Patterson			
Woodland	212	212	
Concord	237	237	
Brandywine Summit	273	273	
Chadd's Ford	129	129	
Fairville	255	255	
Rosedale	312	312	
Kennett Square	260	260	
Toughkennamon	283	283	
Avondale	227	227	
West Grove	444	444	
Penn Station	506	506	
Elk View			
Lincoln University			
Oxford (*b*)			
Rising Sun			
Rowlandville			
Columbia & P. D. Junc. (*c*)CCLIV			

a With West Chester and Philada. R. R. *b* With Peach Bottom R. R.
c On the Susquehanna River above Port Deposit.

Digitized by Google

** *Peach Bottom R. R.*

STATIONS.			
Oxford Junction CCLII			
Hopewell			
Tweeddale			
Spruce Grove			
White Rock			
Kings Bridge			
Fairmount			
Fulton House..................			

** See CCVI.—Levels of this road wanting.

CCLIII. Philadelphia, Wilmington and Baltimore R. R.

Levels of the P. W. & B. R. R. were copied from the profile in the office of the Company at Philadelphia. Assumed level 94 feet too high.
Datum: Ordinary *low* water at Philadelphia = Ocean level.

STATIONS.	Profile.	Corrected Tide.	
Philadelphia.....................			
Southwark	101.40	7.40	
Third Street	120.55	26.55	
Sixth Street....................	126.78	32.78	
Seventh Street	127.58	33.58	
Tenth Street.....................	126.26	32.26	
Twelfth Street..................	120.59	26.59	
Eighteenth Street	129.66	35.66	
Newport Street..................	137.53	43.53	
Greys Ferry Bridge.............	130.59	36.59	
Lazaretto	115.89	21.89	
Paschall			
Darby Street			
Sharon Hill			
Ridley Park.....................			
Chester Bridge (*a*)	118.33	24.33	
Lamokin Junc (*b*)........CCLII			
Thurlow	128.24	34.24	
Linwood........................	124.88	30.88	
Claymont	123.50	29.50	
Holly Oak	103.50	9.50	
Bellevue	108.07	14.07	
Wilmington LVI	101.11	7.11	
Delaware R. R. Junction			
Newport			
Staunton			

a Near Chester Station.
b Philadelphia and Baltimore Central R. R.

Digitized by Google

STATIONS.	Profile.	Assumed Elevation.	Corrected Tide.	
Newark	200.13	94	106.13	106
Iron Hill..................	216.70	94	122.70	123
Elkton....................	122.25	94	28.25	28
North East................	137.75	94	43.75	44
Charlestown				
Perryville (*c*) CCLIV	115.48	94	21.48	21
Susquehanna (*d*)	110.34	94	16.34	16
Havre de Grace	110.12	94	16.12	16
Aberdeen................	169.80	94	75.80	76
Perrymansville	136.39	94	42.39	42
Edgewood................				
Magnolia				
Gunpowder Bridge........	103.78	94	9.78	10
Chase's..................	114.40	94	20.40	20
Stemmer's Run				
Patapsco Neck............	111.13	94	17.13	17
Bayview Junction (*e*)..CC	129.92	94	35.92	36
Baltimore Dep't(*f*)CCLVI	103.33	94	9.33	9

c Port Deposit Branch R. R.
d Susquehanna River, north-east side.
e Northern Central Railway Junction.
f Baltimore and Ohio R. R.

CCLIV. Columbia and Port Deposit R. R.

Elevations on the Columbia and Port Deposit R. R., were copied from a profile furnished by Mr. J. B. Hutchinson, Chief Engineer.

Datum: *Mean* tide at Port Deposit, nearly = Ocean level.

STATIONS.	A. M. T.	Ocean Level.	
Perryville (*a*) CCLIII		(21)	
Port Deposit.....................	8	8	
P. & B. C. R. R. Junc. (*b*) CCLII	35	35	
Conomingo Creek	70	70	
Ball Friar.......	77	77	
Ark Haven	79	79	
Peach Bottom (*c*)	98	98	
Fishing Creek	108	108	
Fights Eddy.....................	118	118	
McCalls Ferry...................	168	168	
York Furnace	176	176	
Shank's Ferry...................	182	182	
Safe Harbor.........	197	197	
Wislar's Run....................	228	228	
Washington......................	231	231	
Columbia (*d*)	240	240	

a Philadelphia, Wilmington and Baltimore R. R.
b Junction with Baltimore Central R. R.
c Peach Bottom R. R. starts from the opposite side of the Susquehanna River. See table CCVI.
d The elevation is in the lower part of Columbia, and is about 4′ lower than where the elevation is given on Pa. R. R. "Elevation on Pa. R. R. track in front of passenger station is 244′."

Digitized by Google

CCLV. *Western Maryland R. R.*

Elevations of the W. M. R. R., were copied from profile furnished through the kindness of Gen. J. M. Hood, President and Gen'l Manager of the road.
Datum: *Mean* tide at Baltimore = ? Ocean level.

STATIONS.	Tide.	Ocean Level.	
Baltimore, Canton Wharf........	20	20	
B. & P. R. R. Crossing (*a*)....CC	150	150	
Oakland			
Arlington			
Mount Hope......................			
Howardville			
Pikesville			
Greenwood			
McDonough....................			
Junction......................			
Owing's Mills..................	480	480	
Timber Grove.................			
Reisterstown..................	600	600	
Glen Morris...................			
Finksburg.....................			
Patapsco.....................	360	360	
Shamberger's			
Parrs Ridge....................	680	680	
Tannery.......................			
Westminster (*b*)...............	680	680	
Avondale			
Smith's Switch.................			
New Windsor	440	440	
Linwood			
Union Bridge..................	350	350	
Middleburg....................			
Frederick Junction (*c*) ...CCVII			
Double Pipe Creek.............			
Monocacy River	280	280	
Rocky Ridge...................	370	370	
Loy's			
Graceham......................			
Mechanicstown	475	475	
Sabillasville			
Blue Ridge Summit (*d*)	1373	1373	
Waynesborough			
Smithsburg....................			
Chewsville....................			
Antietam Creek................	460	460	
Cumbl'nd Valley Junc.(*e*)CCVIII			
Hagerstown	520	520	
Williamsport...................	305	305	

a Baltimore and Potomac R. R. (or Northern Central) Crossing.
b Bachman's Valley R. R., no levels obtainable.
c Frederick Division of Penna. R. R. CCVII.
d Montery Springs Summit.
e Cumberland Valley R. R. Level in table CCVIII is feet.

Digitized by Google

CCLVI. Baltimore and Ohio R. R.

Levels on the B. & O. R. R., were copied from a profile and notes in the office of the Company at Baltimore, by permission of Mr. W. N. Bolling, Engineer.

Datum: The levels are based upon mid tide at Baltimore, and are according to the original survey of the road by Mr. B. H. Latrobe, Chief Engineer, many years ago.

It was impossible to get the levels at all the stations on the road.

STATIONS.	Mean Tide.	Ocean Level.	
Baltimore (Camden Station)......	24	24	
Mount Clair.....................	66	66	
Winan's Station (*a*) CC			
Washington Junction (*b*)........			
Ellicotts Mills...	139	139	
Elysville........................			
Woodstock.......................			
Marriottsville..................			
Sykesville.......................			
Parr's Ridge....................	813	813	
Gaither			
Woodbine........................			
Mount Airy			
Monrovia........................			
Ijamsville			
Hartman's			
Frederick City Junc. (*c*) ...CCIX			
Monocay River..................	262	262	
Frederick City..................	280	280	
Doub's			
Point of Rocks (*d*).............	221	221	
Berlin			
Knoxville (*e*)			
Hagerstown Junction............			
Sandy Hook.....................			
Harpers Ferry (*f*)..............	272	272	
Duffield's			
Kearneysville...................			
Vanclieveville....			
Martinsburg....................			
Shepardstown Road	467	467	
North Mountain.................	547	547	
Cherry Run.....................	398	398	

a Baltimore and Potomac R. R. Crossing.

b Washington Branch B. & O. R. R. diverges from main line at this point.

c Frederick Branch B. & O. R. R.

d Metropolitan Branch B. & O. R. R. connects with main line. *No levels of this line.*

e Washington County Division B. & O. R. R. joins main line at this point. *No levels of this line.*

f Winchester, Potomac & Strassburg R. R. connects with B. & O. R. R. This is one of the R. R's of the State of Virginia.

Digitized by Google

STATIONS.	Mean Tide.	Ocean Level.	
Sleepy Creek....................			
Hancock..................(about)	424	424	
Sir John's Run..................	434	434	
Great Cacapon..................			
Willett's Run			
Rockwell's Run..................			
Doe Gully Tunnel	545	545	
Little Cacapon..................	562	562	
South Branch Potomac River....			
Green Spring Run			
Patterson's Creek...............	568	568	
Cumberland (*g*)..........CCLIX	639	639	
Brady's Mill....................			
Rawlings.......................			
Black Oak Bottom			
New Creek			
Piedmont ....(about)	919	919	
Bloomington....................	993	993	
Frankville			
Swanton........................			
Altamont.......................	2620	2620	
Deer Park.......................			
Oakland			
Huttons........................			
Cranberry Summit...............	2550	2550	
Rodermer's Tunnel...............			
Rowlesburg			
Cheat River....................	1397	1397	
Cassady Summit.................	1856	1856	
Kingwood Tunnel	1820	1820	
Tunnelton.......................			
Newburg........................			
Independence			
Raccoon Run....................	1227	1227	
Thornton.......................			
Grafton (*h*)	985	985	
Fetterman			
Valley Falls.....................			
Texas..........................			
Benton's Ferry..................			
Fairmount......................	888	888	
Barnesville			
Barrackville...............			
Farmington.....................			
Mannington			
Glover's Gap....................	1150	1150	
Glover's Gap Tunnel	1146	1146	
Burton.........................			
Littleton...........			

g Pittsburgh and Connellsville Branch of B. & O. R. R. intersects main line here.

h Parkersburg Branch B. & O. R. R. diverges from main line at this point.

Digitized by Google

STATIONS.	Mean Tide.	Ocean Level.	
Board Tree Tunnel	1104	1104	
North Fork of Fish Creek	887	887	
Bellton			
Welling Tunnel	1193	1193	
Cameron	1049	1049	
Easton's			
Roseby's Rock			
Moundsville (*i*)	661	661	
McMechen's Cut			
Benwood } South Bank of Wheeling Creek }	648	648	
Wheeling, High Water (*j*)	637	(663)	

i Here the R. R. strikes the Ohio River bank and ascends hence to Bridgeport, opposite Wheeling; crosses by a bridge and continues west as Central Ohio Division of Baltimore and Ohio R. R.

j Wheeling.—Mr. J. T. Gardner, in his "Elevations of certain datum points," p. 655 of Hayden's Report of 1873, treats fully of the level of the Ohio River at Wheeling, in relation to the levels of the B. & O. R. R., and arrives at the "probable" conclusion that "the B. & O. R. R. results are too low," giving an improbable fall to the Ohio from Steubenville, exceeding 1 foot per mile, which is known to be its true rate of fall, from P. & S. R. R. and C. & P. R. R. surveys. High water at Wheeling is 637′ by B. & O. R. R. survey of 1832, and the "channel" is 588. This is about 30′ too low. Mr. Gardner makes Wheeling H. W. 1852 . . . . . about 663

CCLVII. Cumberland and Pennsylvania R. R.

Levels on the C. & P. R. R. were furnished by Mr. James A. Millholland, Vice-President of the Company, Cumberland, Md.

STATIONS.	Above Tide.		
Cumberland (*a*) CCLVI	650		
Eckert Branch Junction (*b*)			
Mount Savage Junction (*c*)			
C. & P. Junction (*d*)			
Barrelville			
Mount Savage	1206		
Frostburg	1920		
Neff Run			
Lonacoming	1560		
Barton			
Piedmont (*e*)	928		

a Baltimore and Ohio R. R.—Level of "Cumberland" in B. & O. R. R., Table CCLVI is 639, which, however, is Mr. Latrobe's original level.

b No levels.

c Bridgeport & Bedford R. R.

d Connellsville & Pittsburgh Branch B. & O. R. R.

e Rejoins the Baltimore & Ohio R. R.

NOTE.—This road runs back of the mountain, west of the river, through the Cumberland Coal Basin.

Digitized by Google

CCLVIII. *Cumberland Turnpike Road.*

Levels on the Cumberland Turnpike Road were copied from a report made by Jonathan Knight, Chief Engineer of the Baltimore and Ohio R. R., October 5th, 1835. They were partly taken from a map and profile made by James Schriver, in 1824. Mr. Knight says, in his report, "The levels may be sufficiently accurate for such a road (turnpike), yet are not so exact as levelings taken for a canal or railroad."

Datum: Probably mean tide at Baltimore.

NAMES OF TOWNS, &c.	Above Tide.	
Cumberland.............................CCLVI	635	
Frostburg..................................	1890	
Great Savage Mountain Summit................	2657	
Savage River, 2 miles from its head.............	2376	
Little Savage Mountain Summit................	2535	
Little Backbone Mountain Summit at (Beall's) Dividing Eastern and Western Waters.....	2372	
Meadow Mountain Summit (Alleghany Mtn.)....	2654	
Castelman's River...........................	2077	
Negro Mountain Summit.....................	2826	
Keyser's Ridge Summit, a spur of Negro Mountain..................................	2843	
Winding Ridge Summit.......................	2534	
Smythfield at Youghiogheny River.............	1405	
Barren Hill Summit..........................	2450	
Woodcock Hill or Briery Mountain.............	2500	
Laurel Hill or Most Western Mountain..........	2412	
Munroe at Western Base of Laurel Hill.........	1065	
Uniontown..................................	952	
Cauley's Hill................................	1274	
Brownsville at Monongahela River.............	873	
Hillsborough................................	1750	
Washington.................................	1406	
West Alexandria.............................	1797	
Wheeling...................................	748	

CCLIX. *Pittsburgh and Connellsville R. R.*

Levels on the P. & C. Branch of the B. & O. R. R. were copied from the profile in the office of the Company at Connelsville, Fayette County, Pa.

Datum: As noted on the profile is 200′ *below low water at Pittsburgh*, and 514′ *above mean tide;* therefore 514′ has been added to each elevation, as copied from the profile to get mean tide at Baltimore = ? ocean level.

STATIONS.	Assumed Elevation.	Mean Tide.	
Cumberland (*a*)..........CCLVI	124	638	
Mt. Savage Jun. (*b*)(*c*)IX.CCLVII.	170	684	

a With B. & O. R. R.
b Cumb. & Pa. R. R.
c Bedford & Bridgeport R. R.

Digitized by Google

STATIONS.	Assumed Elevation.	Mean Tide.
Ellerslie	216	730
Cook's Mills	270	784
Bridgeport	424	938
Fairhope	870.5	1385
Southampton	104.5	1564
Glencoe	1119	1633
Philson's	1347	1861
Sandpatch Tunnel	1712	2226
Summit	1772	2286
Myersdale (*d*) CCLX	1549	2063
Garrett (*e*) CCLXI	1433.5	1948
Pinegrove	1360	1874
Mineral Point (*f*) CCXII	1310.9	1825
Castleman	1142.6	1757
Pinkerton	1135	1649
Shoo-Fly Tunnel	1100	1614
Brook Tunnel	1044	1558
Ursina (*g*)		
Confluence	832	1346
Draketown Run	805	1319
Egypt	788	1302
Ohio Pyle	723	1237
Indian Creek	468	982
Sand Works	407	921
White Rock (*h*) CCLXIII	407	921
Connellsville (*i*) CCLXVI	380	849
Broad Ford (*j*) CCLYIV	358	872
Sedgwick	354	868
Dawson (*k*) CCLXV	350	864
Laurel Run	342	856
Oakdale	338	852
Layton	304	818
Barring's	290	804
Jacob's Creek	280	794
Smith's Mill		
Port Royal	278	792
Snyder's	274	788
West Newton	268	782
Sewickley (*l*) XXXI		(780)
Armstrong's	265	779
Robbin's	254	768
Coultersville	254	768
Alpsville	254	768
Osceola	254	768

d Salisbury & Baltimore R. R. Junction.
e Buffalo Valley R. R.
f Somerset & Mineral Point R. R.
g Coal R. R.
h Fayette and Uniontown Branch R. R.
i S. W. Pa. R. R.
j Mt. Pleasant Branch.
k Hickman Run Branch R. R.
l Youghiogheny R. R., Branch of Pa. R. R. difference of 1' in levels at Sewickley.

Digitized by Google

STATIONS.	Assumed Elevation.	Mean Tide.	
Ellrod	254	768	
Long Run	251	765	
McKeesport	251	765	
Riverton	251	765	
Saltsburg	251	765	
Port Perry Junction	251	765	
Braddock's	255	769	
City Farm	247	761	
Salt Works	252	766	
Brown's	243	757	
Grove	270	784	
Hazelwood	275	789	
Frankstown	269	783	
Laughlin	256	770	
Copper Works	249	763	
Soho	255	769	
Birmingham Bridge	237	751	
Pittsburgh. I	237	751	

CCLX. Salisbury R. R.

Levels on the Salisbury R. R. were furnished by Mr. R. I. Batzer, C. E.
Datum: Pittsburgh and Connellsville R. R. at Meyersdale.
This road runs south up Castleman's River, towards the Maryland line.

STATIONS.	Mean Tide.		
Pitts. & Conn. R. R. Junction (*a*) CCLIX	2095		
Meyersdale	2063		
Coal Mines (*b*)	2067		
Romain	2073		
Keystone	2075		
Livengood's Mill	2100		
Salisbury	2131		
Coal Mines (*c*)	2331		

a Junction with Pittsburgh and Connellsville R. R. near Meyersdale, or Myer's Mills.
b Cumberland and Elklich Coal Mines.
c Salisbury and Baltimore Coal Mines.

CCLXI. Buffalo Valley R. R.

Elevations on the Buffalo Valley R. R. were furnished by Mr. S. Philson, President of the Company.
Datum: Pittsburgh and Connellsville R. R.
This road runs north into Somerset County.

Digitized by Google

STATIONS.	Mean Tide.		
Garrett (a)..............CCLIX	1947		
Burkholder....................	1992		
Beaghley's....................	2010		
Bitner........................	2044		
Pine Hill.....................	2064		
Hanger's......................	2073		
Berlin........................	2176		

CCLXII. Somerset R. R.

NOTE.—The records of this road were destroyed by fire. It runs north into Somerset County towards Johnstown.

CCLXIII. Fayette Branch, P. & C. R. R.

Levels on this Branch of the Pittsburgh and Connellsville R. R. were copied from a profile in the office of the Company at Connellsville, Pa., through the kindness of Mr. W. H. Taylor, Resident Engineer.

Datum: Mean tide at Baltimore, Md.

This road runs southwest along the west foot of Chestnut Ridge towards the Virginia State line.

STATIONS.	Mean Tide.		
White Rock (a)..........CCLIX	907		
Fayette.......................	924		
Watt's........................	991		
Dunbar........................	1011		
Ferguson......................	1138		
Mt. Braddock..................	1175		
Lemont's......................	1084		
Evans'........................	1009		
Hoggsett's....................	978		
Uniontown.....................	981		

a Junction with Pittsburgh & Connellsville R. R. just above Connellsville.

NOTE.—The other bridge (at Connellsville) carries the southwest Pennsylvania R. R., which also runs up Dunbar Creek to Uniontown.

CCLXIV. Mt. Pleasant Branch, P. & C. R. R.

Data obtained as the last mentioned.

This road runs northeast along the west foot of Chestnut Ridge.

Digitized by Google

STATIONS.	Mean Tide.		
Broad Ford (*a*)..........CCLIX	873		
Morgan's......................	944		
Tinstman's....................	1076		
Valley Coal Mines..............	1035		
Fountain Mills.................	1040		
West Overton...................	1045		
Iron Bridge....................	1052		
Stauffer's.....................	1057		
Mt. Pleasant...................	1086		
End of Road....................	1083		

a Junction with Pittsburgh and Connellsville R. R. at Broad Ford, 3.2 miles below Connellsville.

CCLXV. Hickman's Run Branch, P. & C. R. R.

Data as above.
This road, one mile long, runs north to Coke Banks.

STATIONS.	Above Tide.		
Dawson Junction (*a*).....CCLIX	872		
Terminus of Road...............	1006		

a Junction with Pittsburgh and Connellsville R. R. near Dawson.

CCLXVI. Southwest Pennsylvania Extension.

Levels on the Extension of Southwest Penna. R. R. were furnished by Mr. John C. Oliphant, Engineer.

Datum is *high tide* in Schuylkill River, at Philadelphia. Add 7′ for ocean level. For the surveys an artificial datum was assumed, as shown in column 1. Column 2 gives this corrected for high tide at Philadelphia. Column 3 corrected for ocean level.

The main road is given in the I series, Table XXX.

This road crosses the Youghiogheny at Connellsville, and keeps up Dunbar Creek over to Uniontown, parallel with the Fayette County Branch of the P. & C. R. R. See Table CCLXIII.

STATIONS.	Assumed Elevation.	Above Tide.	Ocean Level.
Connellsville (*a*).........CCLIX	159.5	908	915
Sub-grade, Pier No. 1............	153.6	902	909
Ordinary Water in Youghiogheny River, at R. R. Bridge, S. W. Penna. R. R................	118	866	873

a Crosses *above* P. & C. R. R. here on a Bridge.

Digitized by Google

STATIONS.	Assumed Elevation.	Above Tide.	Ocean Level.
New Haven	138	886	893
Wheelerville	144	892	899
Dunbar	246.4	995	1002
Ferguson	376.2	1125	1132
Mt. Braddock (*b*)	448	1196	1203
Lemont	274.8	1023	1030
Hoggsett's Mill	205.7	954	961
Uniontown (*c*)	234.2	983	990

b Deep Cut; original surface 485 + 748.5 = 1233.5
c Intersection of Main Street and Broadway.

CCLXVII. Youghiogheny Coal Mine Levels.

Elevations of *Coal openings* on the line of Youghiogheny R. R. furnished by Mr. I. F. Wolf, Engineer Penn Gas Coal Company.

Datum: That of the Pa. R. R.

Youghiogheny Mine, No. 1	720.40
" " " 2	776.40
" " " 4	800.40
Th. Moore's drift at Moore's station P. & C. R. R.	798.40
Markel's Drift at Junction of Yough. R. R	824.44

CCLXVIII. Westmoreland Levels.

Various datum points in Westmoreland County, Pennsylvania, from a survey made by Mr. F. Z. Shellenberg, Superintendent of the Westmoreland Coal Company, Irwin's Station, Penna. R. R.

Datum: That of the Pennsylvania R. R. (Add 7′ for Ocean Level.)

Long Run Presbyterian Church Bench Mark on Door Sill	+ 1150′
Circleville Intersection of Mount Pleasant Turnpike with Greensburg and Pittsburgh Turnpike	1223
Jacksonville. Turnpike east end of town	1152
South Side Mine Mouth Coal	898
Larimer's Coal Mine	961
Ray's Coal Bank; on farm of William Ray's heirs	1052
Robinson's Coal Bank; on farm of R. S. Robinson	989
Bigley's Mines; Mouth of Drain, entry from Armstrong's Osceola Works, P. & C. R. R., at head of Bigley's Main Entry	902
Coal Hollow: Youghiogheny Coal Hollow Coal Company's Mines, between Guffey's and Shaner's Station, P. & C. R. R. Coal	789
Armstrong's Coal, opposite Buena Vista (east)	813
Moore's Coal Mine	812
Suter's Station, P. & C. R. R. Coal	843
Westmoreland Coal Shaft (Coal?)	751
Foster Shaft (Penn Township). Coal	935
Penn Coal Mine, north side of Penn Station, Pa. R. R	927
Kifer's Coal Bank, east of Penn Station, north side of Pa. R. R.	1140
Smith's Coal Bank	1180
Loughner's Coal Bank	1102

Digitized by Google

Harrison City, two miles north of Manor Station, on Pa. R. R., on *bridge* over Brushy Run	967
Cross Roads, two miles west of Harrison City	1185
Salem: *Intersection* of Freeport and Saltzburg Roads, northeast of Salem.	1231
Salem: Burnt Cabin *Summit*, between Allegheny and Monongahela Waters, between Beaver Run and Turtle Creek, one-half mile northeast of Salem.	1200
Salem Cross Roads (Delmont P. O.).	1255
Salem: Coal at Salem Cross Roads.	1272
Bouquet Village *Road*, opposite Grist Mill	1102
Bouquet Coal	1104
William Duff's Steam Grist Mill, *surface of water* just below Mill.	950
King's Bank, Coal at Burnt Cabin Summit.	1208
McQuade's Coal Bank on road leading from Salem Cross Roads to Freeport	1189
John Cochran's Coal Bank.	1132
Thorn Run: *Water* in Run at road crossing Jas. Cochran's farm..	1080
Turtle Creek: *Water* in Creek at northern turnpike crossing, on Waugaman's farm	1051
Turtle Creek: Northern *turnpike* crossing, at Long's.	995
Turtle Creek: *Water* in Creek at Remaly's Mill.	950
Walton's *Summit*, between waters of Turtle Creek and Brushy Run.	1194
Longacre's *Summit*	1187
Brinker's *Summit*	1202
Fink's Run: *Water* at junction with Brushy Run, four miles north of Manor Station, Pa. R. R	1000

CCLXIX. Pittsburgh, Virginia and Charleston R. R.

Levels on the P. V. & C. R. R. were copied from the profile in the office of the company at Pittsburgh, by permission of I. M. Byers, Esq., Superintendent.

Datum:

This road ascends the west bank of the Monongahela River from Pittsburgh to the Virginia State Line, and is in process of completion above Monongahela City. It crosses the river from Pittsburgh to Birmingham on a high bridge.

STATIONS.	Above Tide.	Ocean Level.	
Pittsburgh (*a*)..........CCCLII	750		
12th Street, Birmingham	786		
18th " "	779		
22nd " "	770		
30th " "	745		
Beck's Run	750		
Bird's Run	749		
Street's Run	745		
West's Run	740		
Homestead	745		
Patterson's Run	742		
Opposite Braddock's	730		
Thompson's	749		
Opposite McKeesport	725		
Curry's Run (*b*)	734		

a Junction with the Pittsburgh, Cincinnati and St. Louis R. R.

b On bridge.

Digitized by Google

STATIONS.	Above Tide.	Ocean Level.	
Camden	738		
Rock Run	731		
Pine Run	739		
Peter's Creek	735		
Wylie's	743		
Elizabeth	731		
Walton's	741		
Hodgen's Coal Road	735		
Coal Bluff Road	735		
Houston's Run	740		
Buffalo Coal Works	748		
Mingo Creek	740		
Dry Run	735		
Monongahela City	737		
Pigeon Creek (*c*)	735		
Johnson's Coal Road	750		
Pike Run	719		
West Brownsville (*d*)	758		

c Surface of water at ordinary stage 709.
d In Street in front of Hotel.

VII. ALLEGHENY SERIES.

CCC. Pittsburgh City Levels.

Elevations at different points in the City of Pittsburgh, Pa., were furnished by Mr. William Martin, Assistant Engineer.

Datum: *Low water in the Allegheny River* at the Suspension Bridge, which according to Mr. Jas. T. Gardner's determination, is 699.20′ above the Mean Surface of the Atlantic Ocean. See page 655, Vol. I, Hayden's Geological Survey Report of 1873.

Elevation of Points in City of Pittsburgh, Pa.

BENCH MARKS.	City Datum.	Ocean Level.	
On Window-sill of Monongahela Incline Plane, Check House	407.075	1106.275	
On Belt-course of Union Depot, Main Entrance	47.203	746.403	
On East end Door-sill of Point Breeze Hotel at Intersection of Penn and Fifth Avenue	273.814	973.014	
On Belt-course of Munshall's Distillery, corner Penn Avenue and Water Street	28.198	727.398	
On Door-sill of Post Office	51.554	750.754	
On Embankment of *Lower* (old) Reservoir on Bedford Avenue	165.854	865.044	
On Embankment of *Upper* (old) Reservoir, Bedford Avenue	401.674	1100.874	

Digitized by Google

BENCH MARKS.	City Datum.	Ocean Level.	
On Flow Line of Highland Avenue (new) Reservoir........	365	1064.20	
On Flow Line of Herron Hill (new) Reservoir..................	560	1259.20	
On Flow Line of Brilliant Hill (new) Reservoir............	235	934.20	

CCCI. Allegheny Valley R. R.

Levels on the Allegheny Valley R. R., from Kittaning to Oil City, were copied from notes in possession of Mr. Wainwright, Assistant Engiueer, Engineer's Office, Allegheny Valley R. R., Pittsburgh, Pa.

This portion of the road was leveled during the summer of 1875. The elevation at Kittaning was assumed to be 500′ above tide. The difference between the true elevation and the elevation assumed at the Red Bank intersection of the Bennett's Branch R. R. with the main line, was made to be 284′. This must be incorrect.

Great difficulty has been experienced in connecting the levels of this road with those of others in Northwestern Pennsylvania, and no reliance can be placed upon their exactness. They are evidently *too low*, and the error seems to be in the 284′ feet difference; and therefore in the Bennett's Branch Extension Table, CCCII.

For instance, the level at Parker's City is, by this Allegheny Valley R. R. Table, 579.2 + 284 = 863′; whereas, Mr. Lucas makes it 909′, or 46 feet higher. See Section in Carll's Report of Progress, 1874.

Again, at Franklin this Table gives 678.5 + 284 = 963′; whereas, Lake Shore and Michigan Southern (Franklin Division) Table CCCLXII makes it 444.06 (+ Lake Erie) + 573 = 1017′, or 54 feet higher.

Again, at Oil City this Table gives 983′; whereas Oil Creek and Allegheny Valley R. R. (CCCIV) gives 995′, or 12′ higher. And the same in CCCLXXXVII by the Franklin Branch of Atlantic and Great Western.

The levels of points from Pittsburgh up to Kittaning could not be obtained by any efforts. There seem to be no records, profiles or notes of the levels of this part of the line. Pittsburgh is 745′ by Table I; Gardner makes it 746′, and so does Pittsburgh, Fort Wayne and Chicago R. R., Table CCLXXIII.

STATIONS.	Assumed	Tide.	Ocean Level.	
Pittsburgh..............			(745)	
Sharpsburgh............				
Hulton.................				
Logan's Ferry..........				
Parnassus..............				
Tarentum..............				
Chartiers...............				
Soda Works............				
West Penn Junction (*a*) XXVI...............			(778)	
White Rock............				

a With West Penn. R. R. east to Philadelphia.

Digitized by Google

STATIONS.	Assumed	Tide.	Ocean Level.
Kelly's			
Logansport			
Rosston			
Kittaning	500	784	791
Cowanshannock	498.8	783	790
Pine Creek	502.2	786	793
Templeton	513.9	798	805
Mahoning	514.4	799	806
Reimerton	526.8	812	819
Red Bank Junc. (*b*) CCCII	540.9	825	832
Phillipsburg	545.3	829	836
Brady's Bend	546.4	831	838
Catfish	548.5	833	840
Sarah Furnace	551.5	836	843
Hillsville	555.3	839	846
Monterey	564.7	849	856
Parker City (*c*)...CCCIII	579.2	863	870
Foxburg	586	870	877
Emlinton	595.2	879	886
Dotterer's	604.9	889	896
Black's	612.6	897	904
Rockland	616.6	901	908
St. George's	624.9	909	916
Scrub Grass	637.7	922	929
Brandon's	651.4	936	943
Foster	659.8	944	951
East Sandy	665.4	950	957
Cochran	672.5	957	964
Franklin (*d*) } CCCLXV / CCCLXII	678.5	963	970
† Oil City (*e*)....CCCIV	699.2	983	990

b Junction of Bennett's Branch R. R. Elevation according to profile of Bennett's Branch Ext. of Allegheny Valley R. R. + 824.70, which gives the above mentioned difference of 284', used for reducing the other levels to tide This however depends on the Phila. & Erie R. R. levels, Table , which are as unreliable as those of the Allegheny Valley R. R. The connection between Harrisburg and Pittsburgh, round by the West Branch Susquehanna River, is divisible into three sections, the middle one (Bennett's Branch Extension R.R.) alone being reliable.

c Junction with Parker and Karn's City R. R.

d Junction with Atlantic and Great Western R. R., and with Lake Shore and Michigan Southern (Franklin Division) R. R.

e South Oil City, river rail, main track, opposite lower end of platform of depot. Junction with Oil City and Allegheny Valley R. R.

NOTE.—Seven feet has been added to the second column in the above Table to make the third column agree with levels in Table CCCII.

CCCII. Bennett's Branch Extension R. R.

The levels on the Bennett's Branch Extension, A. V. R. R., were copied from the profile in the office of the A. V. R. R. at Pittsburgh, Pa., through kindness of Mr. H. Blackstone, Chief Engineer.

Digitized by Google

Datum: Tide water at Philadelphia.

This datum, however, is dependent upon the level of the eastern terminus or Driftwood Junction with the Phil. & Erie R. R. But this is known to be too low, and therefore, the levels of the whole line are too low, and carry down with them those of the Allegheny Valley Main Line, as stated in notes, to Table CCCI.

Mr. Burgin's original level on the P. & E. R. R. at Driftwood was 788′. This Mr. Wilson took for his datum level in the surveys of the Bennett's Branch Extension R. R. across to the Allegheny Valley R. R. Mr. Wilson's levels are given in column 1.

On the profile of the P. & E. R. R. used in Table CCXVI, the level of the point of junction is called 795 (7 feet higher). Column 2 makes this first correction, which helps to lift the Allegheny Valley levels a little, but not near enough.

Column 3 is left blank for a future correction, when the levels of the P. & E. R. R. are lifted, as they must be; for, although they start about right at Sunbury, they are already about 20 feet too low at Williamsport by the Catawissa R. R. (LXV), and by the Northern Central R. R. (CC) lists of levels; and feet too low at Lock Haven by the Pennsylvania R. R. (XV) branch lists. At Emporium also they are 18 feet lower than the Buffalo, N. Y. & Phil. Railroad (CCXIX).

But even this 20 feet added to the previous 7′ = 27′ will not suffice to lift the west end of this Bennett's Br. Ext. R. R. high enough to cancel the difference at Franklin and Oil City. It is probable, however, that the whole residual error lies on the Allegheny Valley R. R. line.

STATIONS.	Above Tide.	Above Tide.	Corrected Tide.	Ocean Level.
Driftwood Junction (*a*) CCXVI	788	795		
Mix Run	848	855		
Miller's	880	887		
Dent's Run	898	905		
Enz	938	945		
Grant	949	956		
Mount Pleasant	973	980		
Devil's Elbow	993	1000		
Benezette	1014	1021		
Meadic's Run (*b*)	1073	1080		
Caledonia Tunnel (*c*)	1122	1129		
Slabtown Dam	1163	1170		
Hebner's Run	1245	1252		
Clear Run	1385	1392		
Slab Run	1381	1388		
Fall's Creek	1381	1388		
Crooked Run	1378	1385		
Evergreen	1374	1381		
Maghee's	1361	1368		
Panther's Run (*d*)	1362	1369		
Reynoldsville	1351	1358		
Prior Run (*e*)	1342	1349		
Prindible's	1335	1342		

a With P. & E. R. R. near Driftwood. "795" on P. & E. profile.
b Bench mark on Bridge; West abutment, top of Cap-stone, N. E. corner.
c 250′ east of Tunnel.
d Cap-stone of east Abutment.
e Cap-stone of east Abutment.

Digitized by Google

STATIONS.	Above Tide.	Above Tide.	Corrected Tide.	Ocean Level.
McAnnutty Run (*f*)....	1335	1342		
Camp Run..............	1317	1324		
Fuller's Mill............	1301	1308		
Wolf Run...............	1295	1302		
Cable Run..............	1285	1292		
Iowa Mill..............	1273	1280		
Gooseneck..............	1256	1263		
Bell's Mill..............	1340	1347		
Garrison's Mill..........	1235	1242		
Brookville..............	1209	1216		
Nicholson's Mill........	1199	1206		
Corder's Run............	1200	1207		
Puckerty Point..........	1189	1196		
Rattlesnake Run.........	1183	1190		
Baxter's Mill...........	1181	1188		
Heathville..............	1137	1144		
Motter's Run............	1124	1231		
Bear Tree Run..........	1107	1114		
Maysville	1082	1089		
Pine Run...............	1075	1082		
Millville................	1067	1074		
Indiantown Run.........	1063	1070		
Middle Run.............	1060	1067		
New Bethlehem..........	1054	1061		
Anthony's Neck........	1025	1032		
Leatherwood............	1001	1008		
Rock Run...............	940	947		
Buck Lick Run.........	913	920		
Lawsonham (*g*).........	893	900		
Fiddler's Run...........	889	896		
Red Bank Jun. (*h*) CCCI	825	832		
Sligo Branch of A. V. R. R.				
Lawsonham (*i*)...CCCII	891	898		
Stop's Run.............	913	920		
Fiddler's Run (*j*).......	966	973		
9000 feet (*k*)............	1043	1050		
14,000 feet..............	1141	1148		
15,000 feet..............	1161	1168		
17,000 feet..............	1202	1209		
23,000 feet..............	1325	1332		
Benn's Summit.........	1368	1375		
29,000 feet..............	1305	1312		
Cherry Run............	1198	1205		

f Cap-stone of west Abutment.
g Sligo Branch R. R.
h With Allegheny Valley R. R.
i Junction.
j First crossing; centre of Trestle.
k From the Junction.

Digitized by Google

STATIONS.	Above Tide.	Above Tide.	Corrected Tide.	Ocean Level.
38,000 feet	1218	1225		
Sligo Summit	1300	1307		
Iron Ore Bank	1228	1235		
52,000 feet	1150	1157		
Little Licking Creek	1122	1129		
Big Licking Breek	1102	1109		
Sligo (*l*)	1090	1097		
End of Road	1085	1092		

Boston Branch of A. V. R. R.

Junction (*m*).....CCCII	1049	1056		
Bridge	1050	1057		
2,000 feet	1075	1082		
3,000 feet	1097	1104		
4,000 feet	1118	1125		
5,000 feet	1138	1145		
6,000 feet	1161	1168		

l Sligo Furnace is served by this road.

m There are no stations marked on the profile of this branch. The levels are given at thousand feet from the point of divergence from the main road.

CCCIII. Parker and Karns City R. R.

Levels of the Parker and Karns City R. R. were taken from notes in possession of Mr. Wm. M. Kipp, Engineer at Parker City. The datum of the preliminary survey was an assumed level 100 feet below the top of the west abutment of the iron bridge then building. This datum (as shown by subsequent surveys in locating the line) is 103.99′ below the top of the free-stone base of the toll house. The bridge rises 8′ going east, and there is a further rise from the end of the bridge to the A. V. R. R. depot of 1.98′, as ascertained by Mr. J. F. Carll, which will make the datum of P. & K. C. R. R. below the A. V. R. R. depot 103.99 + 8 + 1.98 = 113.97′. Elevation A. V. R. R. depot, Parker City 863 − 114 = 749 = datum which added to the elevations as copied from notes should bring levels to tide.

STATIONS.	Above Tide.	Above Tide.	Ocean Level.	
Parker Junc. (*a*)..CCCI		863	870	
Stone House	315	1064	1071	
Martinsburg	330	1079	1086	
Argyle	386.80	1136	1143	
Petrolia	401	1150	1157	
Central Point	410	1159	1166	
Karns City	430.33	1179	1186	

a With Allegheny Valley R. R.

NOTE.—Seven feet has been added to the second column in the above Table to make the third column agree with Tables CCCI and CCCII.

Digitized by Google

CCCIV. *Oil Creek and Allegheny River R. R.*

Levels on the Oil Creek and Allegheny River R. R. were copied from the profile in the office of the Company, at Oil City, by permission of C. J. Hepburn, Esq., Superintendent.

Datum: P. & E. R. R.

STATIONS.	Above Tide.	Ocean Level.	
Irvincton (*a*)..............CCXV	1158		
Dunn's Eddy....................	1144		
Penna. House....................	1140		
Thompson's....................	1130		
Cobham....................	1121		
Magee....................	1118		
Tidioute....................	1099		
Trunkeyville....................	1085		
Hickory....................	1078		
Dawson....................	1063		
Jamison....................	1060		
Tionesta....................	1047		
Hunter....................	1048		
Stewart....................	1034		
President....................	1035		
Eagle Rock....................	1033		
Henry's Bend....................	1022		
Oleopolis....................	1019		
Walnut Bend....................	1010		
Rockwood....................	1003		
Imperial....................	995		
Oil City.............CCCLXVII	995		
McClintock....................	1045		
Rouseville....................	1026		
Rynd Farm....................	1030		
Tarr Farm....................	1049		
Columbia....................	1054		
Petroleum Centre....................	1076		
Boyd Farm....................	1073		
Pioneer....................	1086		
Shaffer....................	1120		
Miller's Farm....................	1118		
Titusville..............CCCVIII	1181		
Hydetown....................	1239		
Bridge (*b*)....................	1241		
Gray's Mills (*c*)..........CCCVII	1266		
Meyer's Switch....................	1230		
Tryonville....................	1305		
Centreville....................	1284		
Glynden....................	1335		
Spartansburg....................	1444		
Summit....................	1634		
Stewart's Switch....................	1460		
A.& G.W.R.R.Crossing CCCLXV	1433		
Corry (*d*)................CCXV	1420		

a Junction with P. & E. R. R.
b Near Hydetown.
c Union and Titusville R. R. Junction
d Junction with P. & E. R. R.

Digitized by Google

CCCV. Pithole Valley R. R.

Levels on the Pithole Valley R. R. were furnished by Mr. Aug. Mordecai, Assistant Engineer A. & G. W. R. R. at Meadville, Pa.

STATIONS.	Above Oleopolis	+ Lake Erie	Ocean Level.	
Oleopolis........CCCIV	0	446	1019	
Wood's Mills...........				
Prather................	232	678	1251	
Pit hole City...........	290	736	1309	
Pleasantville...........	615	1061	1634	
Enterprise..............	242	688	1261	
Titusville........CCCVI	162	608	1181	

CCCVI. Dunkirk, Allegheny Valley and Pittsburgh R. R.

Levels on the Dunkirk, Allegheny Valley and Pittsburgh R. R., were copied from a list furnished by Mr. Henry E. Wrigley, C. E., who obtained the levels from the Engineer in charge of the road.

Datum: Lake Erie.

STATIONS.	+ Lake Erie	Ocean Level.	
Titusville................CCCIV	608	1181	
East Titusville..................			
Pleasant Valley.................	755	1328	
Grand Valley...................			
Star	785	1358	
Newton.........................	825	1398	
Summit.........................	878	1451	
Garland........................	695	1268	
Pittsfield.......................	648	1221	
Youngsville.....................	611	1184	
Irvineton.......................	575	1148	
Gravel Pit......................	595	1168	
Jackson	603	1176	
Warren.........................	620	1193	
North Warren..................	643	1216	
Russelburg.....................	660	1233	
Ackley's	663	1236	
Fentonville (*a*)................	670	1243	
Frewsburg......................	688	1261	
A.& G.W.R.R. Crossing CCCLXV	689	1262	
Falconer.......................	685	1258	
Ross Mill......................	689	1262	
Vermont.......................	722	1295	
Sinclairville....................	757	1330	

a State Line of Pennsylvania and New York.

b Surface of water outlet of Chatauqua Lake 675 + Lake Erie 573 = 1248′ Ocean Level.

Digitized by Google

STATIONS.	+ Lake Erie	Ocean Level.	
Moons...........................	730	1303	
Cassadago (c).....................	736	1309	
Skidmore..........................	744	1317	
Norton's..........................	425	998	
Laona.............................	239	810	
Fredonia..........................	192	765	
Dunkirk (d)..CCCLXIII, CLXII	25	598	

c Surface of water 732 + Lake Erie 573 = 1305' Ocean Level.
d On the list from which the above levels were copied, no elevation was noted at Dunkirk, but as the D. A. V. & P. R. R. and the L. S. & M. S. R. R. use the same depot, the tracks being on the same level, and the elevation as given on profile of L. S. & M. S. R. R. taken as correct, it is therefore adopted as the elevation, at the terminus of this road.

CCCVII. *Union and Titusville R. R.*

Levels on the Union and Titusville R. R. were furnished through the courtesy of Mr. C. J. Hepburn, Supt. Oil Creek and Allegheny River R. R.
Datum: P. & E. R. R.

STATIONS.	Tide.	Ocean Level.	
O.C.& A.R.R.R.Junc.(a).CCCIV	1266		
Hydetown......................	1239		
Myer's Switch..................	1230		
Tryonville.....................	1305		
Noble..........................	1285		
Riceville......................	1356		
Lincolnville...................	1369		
Lakeville......................	1399		
Bloomfield.....................	1396		
Union (b)................CCXV	1257		

a Junction with Oil Creek and Allegheny River R. R. at Titusville.
b Junction with Phila. and Erie R. R.

CCCVIII. *Pennsylvania and Petroleum R. R.*

Levels on the Pennsylvania and Petroleum R. R. were furnished by Mr. Aug. Mordecai, Asst. Eng. A. & G. W. R. R., Meadville, Pa.
Datum: Lake Erie.

STATIONS.	+ Lake Erie	Ocean Level.	
Titusville........CCCIV; CCCV	608	1181	
Newton's Mills..................	685	1258	
Athens Mills....................	693	1266	
Little Cooley,..................	630	1203	
Teeple Town.....................	631	1204	
Cambridge.......................	585	1158	
Edinboro........................	639	1212	
Summit..........................	705	1278	
McKean's Corner.................	480	1053	
Erie.................CCCLXIV			

NOTE.—The above levels are from the preliminary survey. The road is not yet built, but the proposed line is from Titusville to Erie.

Digitized by Google

CCCIX. (a) *Buffalo, Corry and Pittsburgh R. R.*

Levels on the Buffalo, Corry and Pittsburgh R. R. were obtained in Oil City, through kindness of Mr. C. I. Hepburn, Supt. O. C. & A. R. R. R.

STATIONS.	Above Tide.		
Corry Junction..CCXV, CCCIV, CCCLXV..................	1423		
Childs..............................	1474		
State Line..........................	1417		
Clymer	1146		
Panama..............................	1545		
Sherman	1568		
Summerdale..........................	1629		
Mayville............................	1300		
Prospect............................	1221		
Brockton (b).........CCCLXIII	672		

a The levels on this road are supposed to be correct, and may be entirely so, but the profile from which the elevations were copied is indefinite as to the exact location of the stations.

b Junction with L. S. & M. S. R. R. Elevation on L. S. & M. S. R. R. at this point is 724′ above Mean Surface of Atlantic Ocean.

VIII. OHIO LINE SERIES.

CCCL. *Pittsburgh, Cincinnati and St. Louis R. R.*

Levels of the Pittsburgh, Cincinnati & St. Louis Railroad, were copied from profile in the office of the Company at Pittsburgh, Pa. The profile was furnished by Mr. S. M. Felton, Jr., Gen'l Supt.

Datum: Pennsylvania R. R. levels? Add 7′ for Ocean level.

STATIONS.	Mean Tide.	Ocean Level.	
Pittsburgh (a) I	(738)	(745)	
Birmingham (b)..................	760	767	
Jones' Ferry....................	757	764	
Temperanceville.................	762	769	
Sheridan	864	871	
Cork Run........................	874	881	
Ingram	880	887	
Broadhead.......................	872	879	
Cemetery Crossing...............	867	874	
Bridge, No. 3...................	824	831	
Bridge, No. 4...................	787	794	
Bridge, No. 5...................	775	782	
Mansfield (c).............CCCLI	775	782	
Walker's Mill...................	820	827	
Oakdale.........................	908	915	
Noblestown	923	930	
Willow Grove....................	988	995	

Digitized by Google

STATIONS.	Mean Tide.	Ocean Level.	
McDonald's	991	998	
Primrose	1023	1030	
Bulger	1146	1153	
Bridge, No. 17	1222	1229	
Burgettstown	1001	1008	
Dinsmore	1082	1089	
Bridge, No. 19	875	882	
Paris Road	858	865	
Bridge, No. 22	829	836	
Collier's (*d*)	826	833	
Holliday Cove			
Edgington (*e*)			
Steubenville (*f*) CCCLV			

a Pittsburgh Union Depot (746′, Gardner.)
b South side of Ohio River.
c Junction with Chartier's R. R.
d In Virginia.
e East side of Ohio River.
f West side of Ohio River and junction with Cleveland and Pittsburgh River Division R. R.

The levels of this road through Ohio are given on page 670, Vol. 1, Ohio Gelogical Survey, 1873; beginning with Steubenville, Washington Street = 155′.

CCCLI. Chartiers R. R.

Elevations on the Chartier's Branch R. R., were furnished by Mr. N. I. Becker, Chief Engineer, P. C. & St. L. Railway, Columbus, Ohio.

Add 7′ to reduce to Ocean level, and substract 1′ for the discrepancy at Mansfield, = 6′.

STATIONS.	Mean Tide.	Ocean Level.	
Mansfield (*a*)........CCCL	776	782	
Leasdale	802	808	
Woodville	807	813	
Bridgeville	825	831	
Boyce's	868	874	
Hill's	873	879	
Greer's	896	902	
Van Emmau's	925	931	
Cannonsburg	936	942	
Houston's	952	958	
Ewing's Mills	981	987	
Cook's	1006	1012	
Washington	1049	1055	

a Junction with Pittsburgh, Cincinnati and St. Louis R. R. In table CCCLXXII 775′.

Digitized by Google

CCCLII. Hempfield R. R.

Elevations on the Hempfield Railway, were furnished by Mr. W. N. Bolling, Engineer B. & O. R. R.

Datum: Mean tide at Baltimore, Md., equal Ocean level. (No connection can be made at Washington between the Hempfield and Chartier's R. R. lines.)

STATIONS.	Mean Tide.	Ocean Level.	
Washington (*a*)......... CCCLI	(1049)	(1055)	
Thompson's Mills..............	699	699	
Chartier........................			
Taylorsville....................	1008	1008	
Claysville......................	683 (?)	683(?)	
Vienna..........................			
West Alexandria................	1099	1099	
Valley Grove....................			
Point Mills.....................	896	896	
Roney's Point...................			
Triadelphia.....................	734	734	
Elm Grove......................	683	683	
Carbon.........................			
Mt. De Chantel.................	674	674	
Wheeling (*b*)....................	644	644	

a Continuation of the Chartier's R. R.
b North and Water Streets 644′. Market Place 662′.

CCCLIII. Pittsburgh, Fort Wayne and Chicago R. R.

Levels of Pittsburgh, Fort Wayne and Chicago R. R., were copied from the profile (in the office at Pittsburgh), furnished through the kindness of Mr. F. S. Slataper, Chief Engineer.

Datum: Lake Erie. Accepted level of Lake Erie above Ocean level is 573′.

The third column adds 1′ to reduce the levels of the second columns to harmony with those of the Pennsylvania R. R.

It is thus seen that the Depot at Pittsburgh is established from the Atlantic side and from the Lake Erie side, with a probable error of about one foot.

STATIONS.	+ Lake Erie	Ocean Level.	Ocean Level.
Pittsburgh (*a*)..................I	173.10	746	745
Allegheny.......................	165.82	739	738
Outer Depot.....................	191.85	765	764
Wood's Run......................	158.65	732	731
Jack's Run......................	156.50	729	728
Bellevue........................	156.50	729	728
Emsworth........................	153.04	726	725
Dixmont.........................	149.77	723	722
Glendale........................	149.30	722	721

a Pittsburgh Union Depot.

Digitized by Google

STATIONS.	+Lake Erie	Ocean Level.	Ocean Level.
Haysville	149.30	722	721
Sewickley	164.30	737	736
Edgeworth	152.80	726	725
Leetsdale	143.44	716	715
Fair Oaks	143.44	716	715
Economy	143.44	716	715
Economy Switch	143.44	716	715
Baden	138.24	711	710
Remington	138.24	711	710
Freedom	130.94	704	703
Rochester (b)............CCCLV	134.24	707	706
New Brighton	178.12	751	750
Beaver Falls	198.83	772	771
Sullivan	293.15	866	865
Wallace Run	322.84	896	895
Homewood (c)..........CCCLIX	376.76	950	949
Highland	471.28	1044	1043
Summit Cut	481.71	1055	1054
Darlington	408.85	982	981
New Gallilee	385.29	958	957
Enon (d)....................434	421.61	995	994
State Line...................472			
Palestine 455	422.46	995	994
Leslie's Run.................479			
New Waterford.............503			
Bull Creek..................515½			
Columbiana................555			
Mill Creek 534			
Beaver Creek 487½			
Green Creek................461			
Gr. Cr. Siding..............454			
Middle York 461			
Franklin...................506			

b Junction with Cleveland and Pittsburgh.
c New Castle Branch R. R.
d From here on the figures on page of the Geol. Survey of Ohio, Vol. I, 1873. Between Columbiana and Franklin is a station now called Leetonia where the New Lisbon R. R. joins. Neither name nor elevation of this point is given, and therefore no connection can be made with Warren by this line.

CCCLIV. Ohio River Water Levels.

Elevation of points above tide from report of Col. W. Milnor Roberts to Canal Commissioners, November, 1840.

	+Lake Erie	Ocean Level.	
Ohio River at Beaver	93	666	
New Castle Pool	222	795	
Conneaut Lake	509.50	1082.50	
Franklin (a)	381.50	954.50	
Allegheny River at Pittsburgh (b)	120.50	693.50	

a This datum is especially valuable in the final determination of the absolute level of the Allegheny Valley R. R. system centering here. But the

Digitized by Google

CCCLV. Cleveland and Pittsburgh R. R.

Levels of the Cleveland and Pittsburgh R. R., were copied from profile in office of Mr. Isaiah Linton, Chief Engineer, Ravenna, Ohio.

Datum: Lake Erie; 573′ above Ocean level.

STATIONS.		Above Lake Erie.	Above Tide.	
Rochester (a)..CCCLIII		137	710	
Beaver (b)	138	137	710	
Industry...............	125	128	701	
Smith's Ferry..........	125	126	699	
Ohio State Line		133	706	
Liverpool..............	120	120	693	
Wellsville	115	115	688	
Linton.................	121	121	694	
Hammondsville	115	115	688	
Salineville	306	306	879	
Yellow Creek (as below)				
Yellow Creek Summit..	543		1116	
Sandy Summit..........	612		1185	
Bayard	503		1076	
Mahoning Summit......	627		1200	
Alliance	516		1086	
Beech Creek (water)....	446		1019	
Beech Creek (rail)......	471		1044	
Lima...................	525		1098	
Atwater................	560		1133	
Summit in Atwater.....	603		1176	
Rootstown	550		1123	
Ravenna Public Square..	560		1133	
Ravenna Station........	530		1103	
P. &. O. Canal	495		1068	
P. & O. Canal, rail on bridge	509		1082	
Cuyahoga River water..	456		1023	
Cuyahoga River bridge..	474		1047	
Hudson Village........	547		1120	
Hudson Station.........	480		1053	
Macedonia	420		993	
Tinker's Creek, (below rail).................	120		693	
Tinker's Creek..........	248		821	
Bedford................	368		941	
Mill Creek.............	210		783	
Newburg	224		797	
Cleveland Euclid street avenue	95		668	
Cleveland Machine shop	56		629	

a Junction with Pitts. Ft. W. & Chicago R. R. 137, (710) is at 850 feet from east end of Bridge. At Rochester Station of that road the elevation is 707.24.

b At Beaver commences a series of levels taken from page 669 of Vol. I, Ohio Geology, 1873.

height of the R. R. track about Allegheny River water at Franklin has not been obtained.

b Mr. Gardner quotes from report of City Engineer, March 15, 1871, (page 655, Hayden's Report of 1873), for Pittsburgh:

Low water, City Datum 699.20
High water, 1852 .... 729.88
High water, 1832 .... 732.95

CCCLVI. River Division C. & P. R. R.

STATIONS.	+Lake Erie	Ocean Level.	
Yellow Creek (as above) (*a*)			
McCoy's........................	111	684	
Elliotsville......................			
Sloan's.........................	125	698	
Jeddo..........................			
Brown's			
Steubenville (*b*)...........CCCL	90	663	
Mingo Junction................			
Lagrange......................			
Rush Run......................			
Portland.......................	90	663	
Yorkville......................			
Deep Run......................			
Martin's Ferry	86	659	
Bridgeport (*c*)............CCLVI			
Bellaire (*d*).............CCLVI	82	635	

a Down the west bank of the Ohio.
b Junction with Pittsburgh, Cincinnati and St. Louis.
c Junction with Baltimore and Ohio R. R.
d Junction Central Div. Balt. and Ohio R. R.

CCCLVII. Beaver Levels.

Bench Marks in vicinity of Beaver, Pa., furnished by Mr. James Harper, County Surveyor, who received the information from notes of Mr. J. N. Hoag, U. S. Engineer.

Bench Marks.

23 Cross cut on door sill of National Plow *Company's building in Rochester*, west door, river front 690.365

26 N. E. corner French and Quay's fire brick works, main building, opposite *Beaver station* on east end top of rubble masonry. Cut on top of rock with cross beside it 668.946

25 Cut and marked with a cross on a flat stone 40 feet from foot of alluvial bank toward river, and opposite a point 50′ west of west end of platform at *Beaver station* 670.348

The above levels were brought from Pittsburgh from a Bench, whose reference above main tide was given by the City Engineer, as determined by the Pennsylvania R. R. level.

CCCLVIII. New Castle and Beaver Valley R. R.

Levels on the New Castle and Beaver Valley R. R., were obtained at Pittsburgh, Pa., through the kindness of Mr. F. S. Slataper, Chief Engineer, P. F. W. & C. R. R. (Late survey).

Datum: Lake Erie, 573′ above Ocean level.

This is part of the Ashtabula, Youngstown and Pittsburgh R. R.

Digitized by Google

STATIONS.	Lake Erie.	Ocean Level.	
Homewood (*a*).........CCCLIII	376.76	950	
Clinton	326.97	900	
Thompson's.....................	286.53	860	
Wampum........................	228.44	801	
Newport	239.36	812	
Moravia	233.02	806	
Lawrence Junction (*b*)..........	201.09	774	
Mahonington	216.04	789	
New Castle (*c*)..................	230.29	803	
Covert's Mills	217	790	
Edenburg........................	229.6	803	
Seymour.........................	224.3	797	
Hilltown	225.6	799	
Quakertown.....................	244.2	817	
Lowell	252.8	826	
Nebo	266.5	839	
Struthers.......................	263	836	
Haselton	257.9	831	
Youngstown.....................	264.4	837	
Brier Hill.......................			
Girard...........................			
Niles			
Warren			
A. & G. W. R. R. (*d*).. CCCLXV			
Champion.....................			
Bristolville			
Oakfield			
Bloomfield......................			
Orwell			
Rock Creek.....................			
Eagleville......................			
Austenburg.....................			
Ashtabula (*e*) CCCLXIII			

a Pittsburgh, Fort Wayne and Chicago R. R.

b Junction with Erie and Pittsburgh R. R. at Lawrence. *R. R. track at this point 40′ above water in river.*

c Junction with New Castle and Youngstown Branch of Pitts. Ft. Wayne and Chicago R. R.

d Atlantic and Great Western R. R.

e Lake Shore and Michigan Southern R. R.

CCCLXVIII. Beaver Coals, &c.

Levels of Coal Basins and other points from report of W. G. Darley, Chief Engineer of New Castle and Franklin R. R., Oct. 7, 1864.

Digitized by Google

	Above Lake Erie.	Above Ocean Level.	
New Castle......................	220	793	
Brier Hill (Mahoning Valley)....	356	929	
Hottenburgh Lower Vein........	520	1093	
Sandy Lake.....................	740	1313	
Sandy Lake, Lower Vein.........	540	1113	
Harrisville.......................	806	1379	
Gillande Summit.................	576	1149	
Franklin	417	990	
Mercer	500	1073	

CCCLIX. New Castle and Franklin R. R.

Levels of the New Castle and Franklin R. R., were copied from a profile of the road furnished by Mr. A. Vandivoort, Supt.
Datum: Lake Erie, 573′ above Ocean level.

STATIONS.	+Lake Erie	Ocean Level.	
New Castle (*a*).......CCCLVIII	220.50	793	
Eastbrook......................	333	906	
Graham's	334	907	
Wilmington....................	355	928	
Neshanock Falls................	419	992	
Volante.........................	462	1035	
Leesburg..................... .	472	1045	
Nelson	487	1060	
Hope Mills	534	1107	
Mercer (*b*)..............CCCLXI	524	1097	
Turner's.........................	571	1144	
Jackson Centre..................	684	1257	
Garvin	754	1327	
Summit.........................	815	1388	
Coulson.........................	704	1277	
Stoneboro (*c*).........CCCLXIII	598	1171	

a Junction with New Castle and Beaver Valley R. R.
b Junction with Shenango and Allegheny R. R.
c Junction with Franklin Division L. S. & M. S. R. R.

CCCLX. Erie and Pittsburgh R. R.

Levels on the Erie and Pittsburgh R. R. were copied from the profile in the office at Erie, through the kindness of Mr. E. N. Beebout, Asst. Engineer.
Datum: Lake Erie. 573′ above Ocean level.

a Junction with New Castle and Youngstown Branch of Pittsburgh, Fort Wayne and Chicago R. R. Table CCCLVIII.
b Crossing of A. & G. W. R. R. See Table CCCLXV.
c Crossing, Franklin Division, L. S. & M. S. R. R. See Table CCCLXII.

Digitized by Google

STATIONS.	+ Lake Erie	Ocean Level.	
New Castle (*a*)........CCCLVIII	236	809	
Harbor Bridge..................	243	816	
Nashua..........................	248	821	
Pulaski..........................	253	826	
Middlesex.......................	260	833	
Wheatland......................	268	841	
Sharon...........................	280	853	
Sharpsville......................	375	948	
Clarksville......................	321	894	
Transfer.........................	417	990	
A. & G. W. R. R. Crossing (*b*) CCCLXV..................	357	930	
Shenango.......................	368	941	
Greenville.......................	388	961	
Jamestown (*c*).........CCCLXII	406	979	
Kasson's........................	538	1111	
Espyville........................	515	1088	
Linesville	460	1033	
Summit (*d*)....................	586	1141	
Conneautville..................	493	1066	
Spring...........................	388	961	
Albion...........................	284	857	
Crosses..........................	192	765	
Girard (*e*)............CCCLXIII	124	697	
Fairview			
Swansville......................			
Erie CCCLXIII			

d The elevation given at a point near Summit is 573′ above Lake Erie = 1146′ above Ocean level.

e Junction with L. S. & M. S. R. R. near Girard.

CCCLXI. Shenango and Allegheny R. R.

Levels on the Shenango and Allegheny R. R. were furnished through the kindness of Mr. Aug. Mordecai, Assistant Engineer A. & G. W. Railway, Meadville, Pa.

Datum: Lake Erie. 573′ above Ocean Level.

STATIONS.	+ Lake Erie	Ocean Level.	
Harrisville.......................	767	1340	
Pinegrove.......................	677	1250	
Pardoe.	632	1205	
Mercer..........................	535	1108	
Cool Spring....................	554	1127	
Freedonia......................	604	1177	
New Hamburg..................	585	1158	
Shenango.......................	364	937	
Greenville (*a*)...........CCCLX	388	961	

a The Shenango and Allegheny R. R. connects with the Erie & Pittsburgh R. R. at Greenville.

Digitized by Google

CCCLXII. *Franklin Division, Lake Shore.*

Levels on Franklin Division of Lake Shore and Michigan Southern R. R. were copied from the profile in the office of the Company at Cleveland, Ohio, by permission of Mr. J. D. Hawks, Asst. Engineer.

Datum: Lake Erie. 573′ above Ocean level.

STATIONS.	+ Lake Erie	Ocean Level.	
Oil City, east (*a*)............CCCI	436.80	1010	
Oil City (*b*)..CCCIV, CCCLXVII	436.80	1010	
Reno (*c*).............CCCLXVII	444.50	1017	
Two Mile Run..................	422.00	995	
Franklin (*d*).........CCCLXVII	444.06	1017	
Midway.......................	423.01	996	
Summit.........................	592.02	1165	
Polk...........................	511.07	1084	
Raymilton......................	564.88	1138	
Midway.......................	600.88	1174	
Naples.........................	591.78	1165	
Stoneboro......................	598.08	1171	
Coal Branch....................	626.08	1199	
Clark's........................	591.30	1164	
Hadley's.......................	497.09	1070	
Salem..........................	424.51	998	
A. & G. W. R. R. Crossing (*e*) CCCLXV................	414.10	987	
Midway.......................	510.00	1083	
Jamestown (*f*)..........CCCLX	416.78	990	
Turner's.......................	487.37	1060	
Simond's.......................	483.72	1057	
Williamsfield..................			
Andover........................	522.20	1095	
Richmond.......................			
Dorsett........................	444.78	1018	
Jefferson......................	368.07	941	
Plymouth.......................	281.20	854	
Ashtabula (*g*).........CCCLXIII	74.52	648	

a Connects with Allegheny Valley R. R. See Table CCCI.

b Connects with Oil Creek and Allegheny River R. R., see Table CCCIV, and with Franklin Branch of the Atlantic and Great Western R. R. See Table CCCLXVII.

c Connects with Franklin Branch of the Atlantic and Great Western R. R. See Table CCCLXVII.

d Connects with Franklin Branch of the Atlantic and Great Western R. R See Table CCCLXVII.

e Crossing, Atlantic and Great Western R. R. near Salem. See Table CCCLXV.

f Crossing, Erie and Pittsburgh R. R. See Table CCCLX.

g Junction with Main Line of L. S. & M. S. R. R.

CCCLXIII. *Lake Shore and Michigan Southern R. R.*

The elevations of the Lake Shore and Michigan Southern R. R. were obtained at Cleveland, Ohio, through the kindness of Mr. J. D. Hawks, Assistant Engineer.

Digitized by Google

Datum: Lake Erie. 573' above Ocean level.

STATIONS.	+ Lake Erie	Ocean Level.	
Dunkirk (a)......CLXII, CCCVI	24.94	598	
Morian's........................	53.15	626	
Brockton (b).............CCCVI	151.11	724	
Portland........................	121.24	694	
Westfield........................	123.66	697	
Ripley Crossing.................	163	736	
Ripley....	176.75	750	
State Line......................	212.18	785	
Northeast.......................	231.4	804	
Moorhead's......................	194.6	768	
Harbor Creek....................	157.	730	
Wesleyville.....................	123.55	697	
Erie (c)..................CCXV	112.5	686	
Swanville.......................	162	735	
Fairview........................	162	735	
Girard (d)...............CCCLX	143.72	717	
Springfield.....................	90	663	
Conneaut........................	78	651	
Amboy...........................	107.75	681	
Kingsville......................	98.40	671	
Ashtabula (e)............CCCLX	74.52	648	

a Connects at Dunkirk with Erie R. R., Table CCXII, and with the Dunkirk, Allegheny Valley and Pittsburgh R. R. See Table CCCVI.

b Connects at Brockton with the Buffalo, Corry and Pittsburgh R. R. See Table CCCIX.

c Connects at Erie with Philadelphia and Erie R. R. See Table CCXV.

d Connects at Girard with the Erie and Pittsburgh R. R. See Table CCCLX.

e Franklin Division diverges from the Main Line at Ashtabula. See Table CCCLXII.

CCCLXIV. Erie City Levels.

Elevations of points in the City of Erie, Pa., were furnished by Mr. Irvin Camp, City Engineer.

Datum: Lake Erie. 573' above Ocean level.

STATIONS.	Above Lake Erie.	Ocean Level.	
Chestnut Street, at Second Street (Lake Bluff).................	70	643	
Chestnut and 26th Street..........	190	763	
Water in Reservoir, City Water Works......................	235	808	

CCCLXV. Atlantic and Great Western R. R.

The levels on Atlantic and Great Western Railway were copied from a profile of road in the office of the Company at Meadville, Pa.

Digitized by Google

Datum: Lake Erie. 573' above Ocean level.

STATIONS.	Above Lake Erie.	Ocean Level.
Salamanca (*a*)............CLXII	811?	1384
Bucktooth........................	798	1371
Red House........................	771	1344
Cold Spring......................	785	1358
Steamburg........................	831	1404
Randolph.........................	702	1275
Waterboro........................	690	1263
Kennedy..........................	676	1249
Poland	694	1267
Levant...........................	683	1256
Jamestown (*b*)...........CCCVI	748	1321
Ashville.........................	777	1350
Panama...........................	855	1428
State Line.......................	885	1458
Freehold.........................	974	1547
Columbus.........................	864	1437
Corry (*c*)..CCCIV,CCCV,CCCIX	866	1439
Concord..........................	780	1353
Union	724	1297
Mill Village.....................	630	1203
Miller's	579	1152
Cambridge........................	585	1158
Venango..........................	556	1129
Saegertown.......................	534	1107
Meadville........................	504	1077
Franklin Junction Branch (*d*) CCCLXVII................	497	1070
Sutton's.........................	526	1099
Evansburg	707	1280
Adamsville.......................	572	1145
Sugar Grove......................	449	1022
Greenville.......................	384	957
Shenango (*e*)...........CCCLXI	371	944
Transfer (*f*).............CCCLX		
Clarksville......................	412	985
Crawford's.......................	318	891
Orangeville......................	370	943
Burghill	483	1056
Johnson's Summit.................	553	1126
Baconsburg.......................	390	963
Warren...........................	327	900
Leavittsburg (*g*)......CCCLXVI	322	895

a Junction with Erie R. R. See Table CLXII.

b Crossing, Dunkirk, Allegheny and Pittsburgh R. R. See Table CCCVI.

c Junction with O. C. & A. R. R. R.; see Table CCCIV. Philadelphia & Erie R. R., Table CCXV. Buffalo, Corry and Pittsburgh R. R., CCCIX.

d Franklin Branch of A. & G. W. R. R. diverges from Main Line three miles southeast of Meadville. See Table CCCLXVII.

e Junction with Shenango and Allegheny R. R. See Table CCCLXI.

f Crossing, Erie and Pittsburgh R. R. See Table CCCLX.

g Junction with Mahoning Division of A. & G. W. R. R. See Table CCCLXVI.

Digitized by Google

CCCLXVI. *Mahoning Division, A. & G. W. R. R.*

STATIONS.	Above Lake Erie.	Ocean Level.	
Colman's (*a*)	265	838	
State Line	259	832	
Hubbard's	328	881	
Veach Mine	350	923	
Doughten's	384	957	
Thornhill	280?	853	
Youngstown	290	863	
Brier Hill	338	911	
Girard	310	883	
Niles (*b*)	336	909	
Warren (*c*)	327	900	
Leavittsburg	322	895	
Braceville	340	913	
Windham	372	945	
Garrettsville	455	1028	
Mantua	536	1109	
Aurora	515	1088	
Pond	450	1023	
Solan	457	1030	
Plank Road	469	1042	
Newburg	240	813	
Cleveland	24	597	

a Junction with Main Line, A. & G. W. R. R.

b Junction with Niles and New Lisbon R. R.

c Junction with Main Line, A. & G. W. R. R.

CCCLXVII. *Franklin Branch, A. & G. W. R. R.*

STATIONS.	Above Lake Erie.	Ocean Level.	
Junction (*a*)	497	1070	
Shaw's Landing	524	1097	
Cochranton	488	1061	
Evan's Bridge			
Utica	457	1030	
Sugar Creek	430	1003	
Franklin (*b*)... CCCLXII	399	972	
Reno	441	1014	
Oil City (*c*)... CCCI, CCCIV	422	995	

a Junction with Main Line A. & G. W. R. R. about three miles southeast of Meadville.

b Connects with the Franklin Division of the L. S. & M. S. R. R. See Table CCCLXII.

c Junctión with Allegheny Valley R. R., Table CCCI; and with Oil Creek & Allegheny River R. R. See Table CCCIV.

Digitized by Google

CCCLXVIII. Sharon Branch, A. & G. W. R. R.

STATIONS.	Above Lake Erie.	Above Tide.	
Junction (*a*)	329	902	
Sharon	285	858	
End of Road	275	848	

a Junction with Main Line, A. & G. W. R. R., near Sharon.

APPENDIX.

Mountain Summit Levels.

Statement of elevations of Summits of dividing grounds of Eastern and Western Waters.

SUMMITS.	Tide.	Ocean Level.	
Nescopeck, N. P. R. R	1635		
Elk & West Creek, P. & E. R. R.	1677		
Sugar Run Gap	2161		
West of Olean, N. Y. & E. R. R.	1672		
Blair's Gap, Allegheny & Portage Railroad	2339		
Wilson's Gap, B. & O. R. R	2620		
Sand Patch, P. & C. R. R	2290		
Clarion, P. & E. R. R	1979		
Catawissa Extension of Little Schuylkill R. R.	1450		
Elmira, N. Y. & E. R. R	1419		
Chambersburg & Pittsburgh (*a*)	2547		

NOTE.—The above levels were copied by Mr. G. W. Leuffer from Mr. Strickland Kneass' memorandum, April 4th, 1866, and are supposed by Mr. Leuffer to be from surveys made by Col. Charles H. Schlatter, in 1838 or 1839.

a Summit between Chambersburg and Pittsburgh, on turnpike.

Clearfield County Levels.

Statement of levels in the Clearfield Region furnished by Mr. E. M. Leuffer, Civil Engineer. Add 3′ for Ocean level.

STATIONS.	Tide.	Ocean Level.	
Tyrone Junction of T. & C. R. R. and Pa. R. R	892	895	
Vanscoyoc	1402	1405	
Gardner's	1553	1556	
Mt. Pleasant	1759	1762	
Emigh's Gap Summit	2025	2028	
Emigh's Gap Summit, Natural Surface of ground	2036	2039	
Osceola	1473	1476	
Pool, Osceola Dam	1444	1447	

Digitized by Google

STATIONS.	Tide.	Ocean Level.	
Mouth of Beaver Run...........	1444	1447	
" Bear Run..............	1467	1470	
" Mountain Branch......	1485	1488	
" Whiteside's Run.......	1488	1491	
" Wilson Run...........	1633	1636	
Crest of Allegheny Mountain at Middle Summit, 3 Spring Gap and source of Moshannon Cr.	2233	2236	
Crest of Allegheny Mountain at Northern Summit, 3 Spring Gap......................	2278	2281	
Crest of Allegheny Mountain, one mile east of Northern Summit, 3 Spring Gap, and highest ground....................	2611	2614	
Crest of Allegheny Mountain in gap between north fork of Sinking Run and Mountain Branch..	2406	2409	
Crest of Allegheny Mountain in gap between Laurel Run and tributary of Mountain Branch..	2364	2367	
Crest of Allegheny Mountain in gap between Bear Run and Mount Pleasant Run..........	2221	2224	
Hale's Coal Bank...............	1638	1641	
Davis' Coal Bank on pike, two miles east of Janesville........	1670	1673	
Little Muddy Run at pike crossing near Janesville............	1450	1453	
Whiteside's Gap in divide between Moshannon & Clearfield waters	1618	1621	
Confluence of Big and Little Muddy Runs.....................	1321	1324	
Spruce Flat Summit in divide between Beaver Run and Clearfield waters..................	1603.5	1607	
Confluence of Big Muddy and Clearfield Creek, near Madeira.	1302	1305	
Houtzdale, Level of top of rail of Railroad at Depot............	1492	1495	
Franklin Colliery Level of bottom of Coal Vein.................	1526	1529	
Surface of water in Clearfield Creek at Glen Hope..........	1319	1322	
Surface of water in Big Muddy Run at turnpike crossing, 1½ mile west of Janesville........	1345	1348	
Hagerty's cross roads............	1568	1571	
Stephen's Summit in Clearfield and Moshannon divide	1722	1725	
Sand Spring, source of the Mountain Branch	2428	2431	
Moshannon Mines three miles west of Osceola (?)............	1465	1468	

Digitized by Google

Centre County Levels.

Elevations of points on experimental line from Bellefonte to Spring Mills, by Mr. J. L. Sommerville, R. E., Bellefonte and Snow Shoe Railroad.
Add 7′ for Ocean Level.

STATIONS.	Tide.	Ocean Level.	
Crossing Nittany Mountain at Heckley Furnace	1867	1874	
Head of Penn's Creek (water)	1129	1136	
Spring Mills intersection with L. C. & S. C. R. R.	1072	1079	
Bellefonte and Lewistown turnpike crossing, Nittany Mountain	1650	1657	

CVII. Lehigh and Susquehanna R. R.

See page 43 above.
The following tables have just been received from Mr. John W. Crellin, A. E., in a letter dated, Mauch Chunk, May 1, 1876.

STATIONS.	Elevations.	Ocean Level.	
Top of rail L. V. Track at			
Phillipsburg CXIV	217.4		
Easton CVII	215.1		
Glendon	215.06		
Hopes	219.51		
Freemansburg	221.73		
Bethlehem	235.54		
Bethlehem Junction	239.35		
Allentown	257.23		
Lower Catasaugu	271.02		
Upper Catasaugu	283.53		
Lauback's	303.82		
Siegfried's Bridge	315.03		
Priechler's	343.95		
Lockport	356.42		
Walnut Port	371.43		
Lehigh Gap	392.73		
Hazardville	416.83		
Bowmansville	435.77		
Parryville	443.33		
Weissport	475.50		
Lehighton	493.71		
Mauch Chunk	532.3		
Coal Port	584.7		
Penn Haven Junction	708		
Penn Haven	723.9		

Digitized by Google

CIX. Nesquehoning Valley R. R.

See page 44, above.

STATIONS.	Elevations.	Ocean Level.	
Nesquehoning..................	801.116		
Hauto	1005.19		
Hometown	1175.64		
Hawk Switch..................	1221.43		
Pamanend	1287.43		

CXII. Lehigh and Lackawanna R. R.

See page 45, above.

STATIONS.	Elevations.	Ocean Level.	
Bethlehem Junction	239.35		
Shimer's	289.129		
Ritter's..........................	298.67		
Brodhead's	313.077		
Steubens'	333.257		
Clyde............................	362.387		
Bath	422.687		
Chapmansville	575.927		

Stated Meeting, January 21, 1876.

Present, 15 members.

Vice-President, MR. FRALEY, in the Chair.

A photograph of Prof. Jas. C. Booth was received and ordered to be placed in the Album.

Letters of envoy were received from the R. Academy at Stockholm, and the R. Observatory at Greenwich.

Donations for the Library were received from the R. Academy at Stockholm, R. Academy and Observatory at Turin, Victoria Institute, Nature, Geological Society at Dublin, American Journal of Science, P. & L. Society at Leeds, Antiquarian Society at Albany, Academy of N. S. at Philadelphia, Franklin Institute, Medical Journal, Engineer

Digitized by Google

Department U. S. A., Congressional Library, Wisconsin Historical Society, and a Committee of the Boston Society of Civil Engineers.

Mr. Chase described a Japanese translation of Dr. Henry Hartshorne's book entitled, "Essentials of the Practice of Medicine."

Mr. Price exhibited a piece of wood, very dry and light, and not at all mineralized, recently obtained from a city well, and desired to place on record the following memorandum:

Two wells for drains have been dug at and near the southern end of the Hotel at the southwest corner of Broad and Walnut streets, the highest part of the old city of two square miles in area. After the surface and brick clay, the digging was through firm blue clay to the depth of thirteen feet from the curb line; then fine gravel; and at the bottom coarse "water gravel," which was penetrated to the depth of 27 feet from the curb, where the digging ceased, without going below that gravel. The lower was the coarsest, with pebbles two or three inches in diameter; and through it were scattered some unrounded stones, with angles more or less sharp, but only a few inches in length, and the largest not over eight inches long. Near the bottom was found the limb of a tree, two inches thick in the broadest diameter.

Mr. Blodget described the clays and gravels underlying the city, and a map of Broad street, from South street to League Island, which he had published to show that they were evenly deposited at about the level of tide.

Mr. Blodget said that, in the borings on League Island which he superintended, the gravel beneath the clay was proved to pass under the water and forms the river bed, affording good holding ground for ships everywhere, the central channel being 33 feet deep, and the inshore soundings 16 feet below low water mark. A little mud is seen at the upper end of the island. The southern end shows a tough clay, which sets or hardens on exposure, and is used for embanking. At Point Breeze, in excavations for the large bank, one foot of quicksand was found 45 feet down, under which lay firm gravel; the series from the surface downward being 1, top loam; 2, sandy clay and blue clay; 3, gravel. Piles 18 feet long driven through blue clay took firm hold in the lower gravel.

Mr Tathem said that at Fifth and Walnut streets there were two gravels, separated by 20 feet of blue clay and mud, a pure slimy blue clay without a particle of gravel.

Morris, Tasker & Co.'s well in Southwark went down 70 feet before striking rock, and continued in the rock to a depth of 250 feet.

Mr. Price said that his present excavations at Twenty-eighth and Oxford

Digitized by Google

streets, show at 15 feet from the surface a black streak 2 inches thick, the whole mass being gravel as far as they have yet gone.

Mr. Blodget recounted the experience of those who laid the foundations of the Masonic Temple, Broad and Filbert, where two gravels were found separated by 8 feet of quicksand, which required two powerful steam pumps 6″ and 8″ working night and day. The top of the quicksand layer was accidentally uncovered at the corner of the lot 40 feet deep, and this obliged the plan for laying the foundation to be entirely changed at an expense of say $30,000.

The great tower of the Public Buildings opposite to the Masonic Temple, has its foundation laid in the upper gravel, and there is a possibility of future disaster from the subjacent quicksand.

Dr. Cresson communicated also the following record and analyses of the boring at the Continental Hotel, at the corner of Chestnut and Ninth streets:

Analysis of Water from Artesian Well at Continental Hotel and Schuylkill River.

Analysis made by..........Charles M. Cresson, M.D., 417 Walnut Street.
Sample received..March 22, 1875.
" amount of (U. S. G. = 231 Cubic Inches, = 8.332698)....4 gallons.
Analysis made.................................March 23d—April 15th.

Condition of sample.........................Small amount of Sediment.
Reaction...Neutral.

Analysis No. 1442.			Artesian W. Grains in 1 U.S. Gallon	Schuylkill R. Grains in 1 U.S. Gallon
Sediment				
Solid matter upon evaporation to dryness			13.58000	6.99000
" " " " " after ignition				5.06000
Organic Matter (Carbonic Acid, &c.), by loss on ignition				1.93000
Silica		($Si O_3$)	2.11800	0.65000
Alumina		($Al_2 O_3$)	} 0.42800	0.05100
Oxide of Iron		($Fe_2 O_3$)		0.05900
Lime		(Ca O.)	1.47448	0.94640
Magnesia		(Mg O.)	0.46908	0.53280
Carbonic Acid		(CO_2)	not det.	not det.
Sulphuric acid	free	(SO_3)	none	none
" "	in combination		0.68750	1.18000
Chlorine	free	(Cl.)	none	none
"	in combination		0.65000	0.50000
Potash		(KO.)	} chiefly	} chiefly
Soda		(Na O.)	potash.	soda.
Ammonia	free	(NH_3)	0.00646	0.00850
"	albumenoid		0.00442	0.02142
Nitrogen from Nitrates and Nitrites			0.18360	0.17000
Sewage			0.04420	0.21420

Digitized by Google

Well at Continental passed through,	Thickness of strata.	Total depth.
Sand and Gravel to Rock at........................	40 feet.	40 feet.
Blue Gneiss..	100 "	140 "
Feldspar...	1 "	141 "
Light Grey Gneiss..................................	38 "	179 "
Pure Feldspar......................................	27 "	206 "
Pump down to.......................................	178 "	384 "

Is a purer and better drinking water than that supplied from the Schuylkill, and equally good for household purposes. In March 1874 and 1875 water became muddy for four hours and then clear again.

Mr. C. E. Hall communicated, through the Secretary, a List of Genera and Species of Fossils determined by him during 1874 and 1875, to be included in his report on the Fossils of Pennsylvania for the Geological Survey.

Mr. Lesley communicated a list of 2,500 station-levels in Pennsylvania, collated from railway and other records, by Mr. Charles Allen, of the Geological Survey.

Mr. Chase communicated certain conclusions deducible from the curves of rainfall in North America.

Mr. Lesley was elected Librarian.

The following Standing Committees were appointed for the ensuing year:

Finance,

Mr. Frederick Fraley,
Mr. Eli K. Price,
Mr. Benjamin V. Marsh.

Publication,

Dr. John L. LeConte,
Dr. Daniel M. Brinton,
Dr. Harrison Allen,
Dr. Charles M. Cresson,
Mr. William M. Tilghman.

Hall,

Gen. Hector Tyndale,
Mr. Edward Hopper,
Mr. Solomon S. Roberts.

Digitized by Google

Library,

Dr. Benjamin H. Coates,
Mr. Eli K. Price,
Dr. Joseph Carson,
Dr. Charles T. Krauth,
Dr. George H. Horn.

Pending nominations 791, 792 were read.

Pending nomination No. 791 was balloted for.

The reading of the list of surviving members was postponed.

The annual report of the Trustees of the Building Fund was presented and referred.

On motion of Mr. Price, an appropriation of $500 was made for the immediate binding of the unbound Serials in the Library.

On motion of Mr. Blodget, it was

Resolved, That a Committee of this Society be appointed to consider the propriety of attempting a representation of the progress of research in Physical Science in the United States at the coming Centennial, and of inviting the co-operation of other Societies in such representations.

Mr. Blodget, Dr. Barker and Dr. Campbell were appointed the Committee.

On scrutiny of the ballot box by the presiding officer, it was announced that:

Dr. J. Gibbons Hunt was duly elected a member of the Society.

And the meeting was adjourned.

Digitized by Google

NEBULAR ACTION IN THE SOLAR SYSTEM.

By Pliny Earle Chase,

PROFESSOR OF PHILOSOPHY IN HAVERFORD COLLEGE.

(Read before the American Philosophical Society, April 21st, 1876.)

In studying the special evidences of nebular action, we find various significant relations, based on the following cardinal planetary positions, for which Stockwell's* values are taken:—

	Secular Perihelion	Mean Perihelion	Mean.	Mean Aphelion	Secular Aphelion	Secular Range
☿	.29743	.31873	.38710	.45546	.47677	.17934
♀	.67224	.69779	.72333	.74888	.77442	.10218
⊕	.93226	.98613	1.00000	1.03387	1.06774	.13547
♂	1.31105	1.40322	1.52369	1.64416	1.73633	.42528
♃	4.88632	4.97824	5.20280	5.42735	5.51927	.63295
♄	8.73445	9.07764	9.53885	10.00006	10.34325	1.60880
♅	17.68803	18.32298	19.18358	20.04418	20.67913	2.99111
♆	29.59817	29.73221	30.03386	30.33551	30.46955	.87138

1. The minimum eccentricities of the principal planets, as found by Stockwell are:—Neptune, .00557; Uranus, .01176; Saturn, .01237; Jupiter, .0255; Earth and Venus, each, 0. The ratios, counting towards Sun, are, therefore, ♆ ÷ ♅ = 1 : 2.11; ♄ : ♃ = 1 : 2.07. The closeness of these approximations to the fraction ½, suggests their probable dependence on a fall through a half-radius, which would give the particles of a nebulous ring the velocity of separation.

2. The secular ranges of the planets present many suggestive features. Jupiter's (.63295) corresponds with Earth's orbital radius of spherical gyration (.63245); Saturn's (1.6088), with the nucleal tendency of Earth's kinetic radius, $(1.4232^{\frac{4}{3}} = 1.6009)$; Uranus's (2.99111), with the asteroidal belt, and with a linear pendulum of which Earth occupies an oscillatory centre; Mars's, with the centre of linear oscillation of Jupiter's; Venus's, with the centre of explosive oscillation of Mercury's; the range sum of Neptune and Earth, (1.00685), with Earth's mean vector-radius; of Venus and Mercury, (.60462), with the kinetic atmosphere (.60087); the sum-ratio of Earth and Venus, (.23765), with the ratio of Mercury's greatest eccentricity (.23172).

3. Stockwell's estimates for the maximum secular eccentricity, Bessel's for the masses of Jupiter and Saturn, and Newcomb's for those of Uranus and Neptune, give the following values for the positions of centres of gravity, at secular perihelion, mean, and secular aphelion, the unit being Sun's radius:

*Smithsonian contributions, 232, pp. 37, 38.

Digitized by Google

.	Perihelion.	Mean.	Aphelion.	Approximate Ratios.
☉ ♃	1.0019	1.0668	1.1318	1
☉ ♄	.5360	.5883	.6347	½
☉ ♅	.1681	.1824	.1966	⅙
☉ ♆	.3228	.3276	.3323	⅓

These values likewise exhibit a close approximation to the perihelion ratio ⅓, between the companion planets of each pair, together with indications of nebular rupture between Saturn and Uranus, and of increasing condensation towards Neptune and Jupiter. The perihelion ratio of Neptune: Jupiter = 1 : 3.1; that of Uranus : Saturn = 1 : 3.2, or nearly that of a nodal division, to the entire length, of a linear pendulum. The reversal in the direction of condensation, between the central and the exterior belt, may perhaps explain the retrograde satellite motions of Uranus and Neptune.

4. If we compare the perihelion and the aphelion centres of gravity of companion planets, we find that .6347 is near the centre of spherical gyration $\left(\sqrt{.4} \times 1.0019 = .6336\right)$ of 1.0019, and that .1681 is near the centre of nebular rupture *(.1661) of .3323.

5. The time of revolution varying as $r^{\frac{3}{2}}$, while the time of rotation with the velocity due to interior *vis viva* varies as $r^{\frac{1}{2}}$, the limiting radius of synchronous rotation and revolution, for any given expanding or contracting nucleus, is a mean proportional between the limiting radii of interior and exterior nucleal rupture. I have shown that the gravitating impulses are $4565 \times (10)^{11}$ per second, corresponding in frequency with the red rays of light, and the modulus of light is

$$\left[\frac{365.256 \times 86400}{2\,\pi \times \sqrt{214.86} \times 497.825}\right]^2 = 473755 \text{ solar radii.}$$

If modulus were taken as the primitive radius of resisting inertia, $(r)^{\frac{3}{2}}$, Neptune's position would accord with the corresponding nucleal radius ($r = 6077.2$ solar radii), and Mercury's with the radius of internal rupture ($r^{\frac{1}{2}} = 77.96$ solar radii) Saturn's place being fixed, as we have seen, by the centre of nucleal planetary inertia, its *mean* aphelion radius appears to have influenced Neptune's position, while Earth's *secular* aphelion exerted a like influence on Mercury's position; for $1.04835 \times 6077.2 = 6371$, Neptunes secular perihelion being 6359.5, a difference of less than ⅕ of one per cent.; $1.06774 \times 77.96 = 83.24$, Mercury's mean distance being 83.17, a difference of about $\frac{1}{12}$ of one per cent.

6. The mean proportional between these values of $r^{\frac{1}{2}}$ and r, as well as between Sun's radius and modulus, is 688.3 solar radii, or 3.203 times Earth's mean radius vector, which is near the outer limit of the asteroidal belt. This agrees very closely with the secular range of Uranus (2.99111), and the relation is still closer to the ratio between the gravitating radii of Saturn

*Velocity at $\frac{1}{2}\,r = \sqrt{2gr}$.

Digitized by Google

and Uranus $\left\{\frac{5883}{1824} = 3.209\right\}$. The positions of the principal masses in the three chief companion planetary pairs, indicate the same law of mean proportionality, between interior and exterior rupturing tendencies. For Jupiter's secular aphelion (5.5193) is at the geometrical mean (5.5195) between Earth's mean distance and Neptune's secular aphelion (30.46955). Neptune's secular perihelion (29.598) is within one per cent. of 6 $\times$ Jupiter's secular perihelion, or in inverse ratio of the indices in my equation of products of figurate powers, ($♆^1 \times ♅^3 \times ♃^6 = ♄^{10}$).

7. The nodal influence of linear centres of oscillation, on material particles which are subjected to radial "lines of force," is shown in the vector-radii of the three outer planets, (Saturn, *mean aphelion*, 10; Uranus, *mean aphelion*, 20.044; Neptune, *mean*, 30.084). This tendency would be aided by the apparent primitive interposition of Sun between Jupiter and the exterior planets; for Saturn's vector-radius is so small, in comparison with modulus, that the above positions represent the geometrical progression, $(n + 1)$, $(n + 1)^2$, $(n + 1)^3$, as well as the arithmetical peudulum progression, 1, 2, 3, thus satisfying the requirements, both of elastic media and of simple force-lines. The many indications that Jupiter and Saturn were once parts of the same nebular belt, with a mean nodal difference* of 180°, serve to connect those accordances with the figurate equation.

8. As further clews to the significance of the figurate equation, it may be well to note the closeness of the accordance between the mass-ratios ☉ : ♆, 6π ☉ : ♃, and the distance-ratio $(♃ : ⊕)^6$; as well as Stockwell's ratios* of mean perihelion and node-motion.

9. The radial light oscillation which is synchronous with the present limit of possible circular revolution, is 10020.″25 ÷ 497.″825 = 20.128 Earth's vector-radii, which is also the rupturing radius of the retrograde-satellite and the direct-satellite planets, the difference between the secular aphelia of Saturn and Neptune, (or the vector-radius of Neptune relatively to the nebular planetary centre of inertia), being 20.126; the mean aphelion vector-radius of Uranus = 20.044; the major axis of the November meteors, and the secular aphelion of Uranus, each = 20.68; twice Saturn's secular aphelion = 20.69; the original nebular activity thus combining with the satellite influences, in maintaining Saturn's rings. Moreover, Neptune's secular perihelion = 1.4313 $\times$ the secular aphelion of Uranus, (the "kinetic radius" or the limiting radius of equality, towards which I have shown that *all* central forces mathematically tend, being 1.4232).

10. The sum of Uranus's mean, and Earth's secular perihelion vector-radius = 20.0158. The importance of Earth's position, the near approximation of this sum to the cardinal light oscillation (9), and the indications of a somewhat shorter major-axis for the inner meteors of the November stream, encourage us to look for still further evidences of continuing nebular activity, in our own orbit as well as in that of Saturn. If Earth and Uranus were once parts of an elliptical ring, or meteor current, with

Stockwell, *op, cit*, p. xiv.

Digitized by Google

Earth sharing Uranus's present maximum secular eccentricity (.077965). Earth, Jupiter, Uranus, and Sun, were connected by the following equation:—Modulus $= 2\pi \times$ the square of Jupiter's mean radius vector $\times$ the time of revolution at secular perihelion (.922035) of a mean-proportionate radius between Earth and Sun $\left(1 : \sqrt{214.86}\right)^{\frac{3}{2}} \div$ (square of Earth's radius $\times$ 1 year). This value of modulus (474250) exceeds the value found by the ordinary methods (473755), by less than $\frac{1}{8}$ of one per cent.

11. The secular range of Uranus, between 17.688 and 20.679, subjects all the intra asteroidal planets, together with most of the asteroidal belt, to the influence of its accompanying light-oscillations, so that all the members of our interior system of dense planets may have been partially built up of materials from a meteoric stream, of which the November meteors are the *débris*. Earth's secular aphelion (1.0677; Cfr. the ratios of ♃ ⊙ centre of gravity, 1.0668, and of Jupiter's secular aphelion, 1.0608) was established near the linear centre of gravity of a pendulum, of which the kinetic radius marked the centre of oscillation ($\frac{1}{2} \times \frac{3}{2} \times 1.4232 = 1.0674$). Venus's secular perihelion (.6722), is near the centre of spherical gyration of Earths secular aphelion $\left(\sqrt{.4} \times 1.0677 = .6753\right)$.

12. If we take the primitive light-axis (20.128), and suppose it subjected to repeated oscillations through $\pm$ Earth's mean vector-radius, successive nodal bisections give the following approximations:

$20.128 - 1 = \alpha$	19.128	Uranus.	19.184
$\frac{1}{2}\alpha = \beta$	9.564	Saturn.	9.538
$\frac{1}{2}(\beta + 1) = \gamma$	5.282	Jupiter.	5.203
$\frac{1}{2}(\gamma - 1) = \delta$	2.141	Asteroids.	
$\frac{1}{2}(\delta + 1) = \epsilon$	1.571	Mars.	1.524

13. If the kinetic radius of Mercury's secular perihelion was also the radius of nucleal separation, its secular aphelion (102.438) was near a corresponding atmospheric radius ($1.4232^{\frac{4}{3}} \times 63.906 = 102.305$).

14. If the luminiferous, or kinetic æther is the permanent representative of the original hypothetical nebula, in which suns and planets are but floating particles, Faraday's "lines of force" may be due to longitudinal and transverse waves, either of various degrees of velocity but uniform frequency, or of various frequency but uniform velocity, or of velocities and frequencies both varying, in accordance with definite harmonic laws. The luminous, thermal, magnetic, gravitating, cohesive, and dissociating impulses,* all have simple harmonic representatives in the 26th musical octave, which is the special octave of light-proper; the gravitating impulses have also important harmonics in the 46th, 91st, and 92d octaves.

*The "selenium eye" illustrates one of these harmonies. Prof. W. G. Adams, (Proc. Roy. Soc. Jan. 6, 1876; P. Mag. April 1876) says: "the change in the resistance of Selenium is directly as the square root of the illuminating power." This is inversely as the velocity of nucleal rotation. The deflections in the dark (32) and in the strong sunlight (470) give the ratio 14.69; the ratio of emanating force at Sun, to that at Earth's orbit being 14.66.

Digitized by Google

15. Jupiter, the chief planet in the supra-asteroidal, and Earth, the chief planet in the intra-asteroidal belt, are connected by the following proportion. The number of light-oscillations (log. = 20.699916) which would communicate the greatest gravitating velocity in our system ($\sqrt{2gr}$ at Sun) : the number (log. = 15.822542) in describing Sun's circumference ($2\pi r$) : : velocity of revolution at earth ($1 \div \sqrt{214.86}$) : velocity of gravitating fall at Jupiter $(1 \div 1051.298)^2$, the units of velocity being taken, respectively, at Sun's surface, and at the limit of equilibrium between ☉ ♃ aggregation or dissociation (1.4232 + 1049.875).

16. The same chief planets are also connected by the proportion :— $\sqrt{\text{Modulus}}$ (688.3) : light-producing wave at the mean-perihelion centre of gravity of Sun and Jupiter ($\pi \times 1.0198$) : : Earth's mean radius vector: Sun's radius. The value of Earth's radius-vector thus found, is 214.842; the value which is derived from the observations which I have thought the most accurate, being 214.86.

17. Jupiter and Sun thus appear to be companion constituents of a binary star, and the point of primitive rupture should be sought at the secular perihelion centre of gravity. Bodies falling toward that point, or approaching Sun, are subject to a force of about 1048 towards Sun, and 1049 towards the slowly moving common centre of gravity. There are, therefore, two nodal points, with the least resistance to motion nearly midway $\left[\frac{1048}{2097}\right]$ between them. If Sun is gaseous, as Hunt, Faye, and others have supposed, there should hence arise linear oscillations of $2 \times 2r$, synchronous with the circular oscillations of $2\pi r$. The corona may, perhaps, be due to such radial oscillations.

18. The 15th accordance gives for the mass of Sun ÷ Jupiter, 1049.875 — 2 = 1047.875; the 17th, 1049.874 — 2 = 1047.874; Bessel's estimate being 1047.879 ± .235.

19. The discrepancy between the two astronomical estimates for the velocity of light, seems to have arisen from ignorance of the internodal oscillation. Delambre, from his discussion of more than 1000 eclipses of Jupiter's first satellite,* estimated the time of light-passage from Sun to Earth at $493.^{s}198$; Struve, from the phenomena of aberration, at $497.^{s}827$. If the time of traversing 212.86 solar radii is 493.198, the time for 214.86 r should be 497.831, which differs from Struve's value by less than $\frac{1}{1000}$ of one per cent.

20. If Earth was at the nebular nucleal *surface*, when the Jovi-Saturnian ring was nebularly atmospheric, the *vis viva* of interior nucleal rotation varied as r; and the velocity of resulting planetary revolution, as $r^{\frac{1}{2}}$. We thus obtain, for the theoretical time of present solar rotation, $\sqrt{214.86} : 1$: : $365.^{d}256 : 24.^{d}912$. The lowest estimate from observation is Spörer's 24.624; the highest, that of Schwabe, 25.507.

*Stockwell, *Proc. Amer. Asso.* xx. 76-7.

Digitized by Google

21. The laws of central forces require that provision should be made for radial oscillations, tending towards the time-limit of iso-radial circular oscillations $(\sqrt{32}$ and $\sqrt{8})$; for tangential velocities, varying inversely as the times and directly as the fourth root of central iso-radial *tendencies;* for centres of oscillation in lines of force, and for oscillations between systematic and locally dominant centres. We have already seen (15, 17, 18,) how closely the relative masses of Sun and Jupiter provide for the last requirement; if they provide also for the others, the centre of oscillation for Sun's possible atmosphere should be at $1047.875 - (\sqrt{32})^4 = 23.875$ solar radii. The corresponding height of possible atmosphere, or the height of equality between the velocities of rotation and revolution, is $\frac{3}{2}$ of $23.875 = 35.813\, r$. This would give, for the time of solar rotation, $365.256 \div (214.86 \div 35.813)^{\frac{3}{2}} = 24^d.856$, differing less than $\frac{1}{4}$ of one per cent. from the *vis viva* estimate (20).

22. The ratio $1 : 32^2$ is also simply connected with the mass and distance of Jupiter's companion planet, Saturn, and so with the centre of planetary inertia. For $1024 + 1025 + .536 = 2049.54$ (3,17), Saturn's mean radius vector being 2049.51 solar radii; $1024 + (35.813 \div \sqrt{.4}) = 1080.625$ is the limit, of which Jupiter represents a centre of explosive oscillation, and the inertial moment at the limit gives the mass of Sun $\div$ Saturn; for $1080.625 \times (\frac{9}{5})^2 = 3501.2$, Bessel's value being 3501.6.

23. Among the many harmonies of planetary mass which manifest a dependence on nebular influences, the following are, perhaps, indicative of some of the earliest forms of activity.

a. The masses of Jupiter and Earth are nearly proportionate to the squares of their periodic times $\times$ the velocities due to internucleal *vis viva;* $5.2028^3 \times 5.2028^{\frac{1}{2}} = 321.2$; $321.2 \times 1047.875 = 336201$.

b. The influence of *spherical* gyration on Venus (11), seems to be further shown by its ratio to Earth, which is the *square* of the ratio of Uranus to Neptune $(\sqrt{8} : \pi) : \pi^2 \times 336201 \div 8 = 415289$. Hill's estimate of the mass of Sun $\div$ Venus is 408134. If the internucleal *vis viva* of Jupiter were taken at secular perihelion, the resulting theoretical mass-denominators would be Earth, 326222; Venus 402460.

24. The masses of the principal planets, therefore, seem to have been primitively determined by the following influences:—Neptune, by the proportion between the time of direct fall to the centre of planetary inertia, and the time of circular revolution; Uranus by the time of describing the same proportional part of a circle, in the circular orbit; Saturn, by equality of nebular *vis viva* with Jupiter, when the two centres of condensation were in opposite parts of the nebular belt and on opposite sides of the sun; Jupiter, by the ratio of variability, between incipient fall to a centre of linear atmospheric oscillation and circular revolution; Earth, by the combined action of *vis viva* and time of revolution; Venus, by the action,

Digitized by Google

in a spherical mass, of the same force as determined Uranus in a circular disc. The mass-denominators are,

	Theoretical.	Observed.	Authority.
♃ $32^2 + 23.875$	1047.875	1047.879	Bessel.
♄ $\left(\frac{9.539}{5.203}\right)^2 \times$ ♃	3522.3	3501.6	Bessel.
♆ $\sqrt{32} \times$ ♄	19925.3	19700	Newcomb.
♅ $\pi \times$ ♆ $\div \sqrt{8}$	22133.4	22600	Newcomb.
⊕ $5.203^3 \times 4.886^{\frac{1}{2}} \times$ ♃	326222	322800	Newcomb.
♀ $\pi^2 \times$ ⊕ $\div 8$	402460	403134	Hill.

25. These masses, with Hansen and Olufsen's mass for Mars, and Encke's for Mercury, give the following ratios for the extra and intra asteroidal groups :—

	Theoretical.	Observed.		Theoretical.	Observed.
♃	1.0000	1.0000	⊕	1.0000	1.0000
♄	.2975	.2993	♀	.8106	.7909
♆	.0526	.0532	♂	.1019	.1009
♅	.0473	.0464	☿	.0670	.0663
	1.3974	1.3989		1.9795	1.9581

Here is a further approximation, in the inner system, to the square of the outer ratio, accompanied by suggestive indications of the influence of the ratio between aggregating and dissociating velocities $(1 : \sqrt{2})$, and of the ratio between the oscillatory and kinetic radii (1.4232 : 2 : : 1 ; 1.405). The outer is about 220 $\times$ the inner, or nearly as Earth's radius-vector is to Sun's radius.

26. To the primitive influences others were subsequently added, depending upon mutual actions and reactions, some of which have already been pointed out, and others are obscurely intimated by harmonies which can hardly be regarded as accidental. To this latter class the following may be added:—

a. Jupiter's mass is to Neptune's mass, as $\pi \times$ Neptune's radius vector is to Jupiter's radius vector; Neptune's mass is to Earth's mass, as $\pi \times$ Jupiter's radius vector is to Earth's radius vector.

b. The mass of the intra-asteroidal planets : Sun's mass : : square of Jupiter's secular aphelion : square of light-modulus.

c. The limit of possible solar atmosphere : $6^2 \times$ Sun's radius : : Earth's polar: Earth's equatorial diameter. ($6 = 2 \times 3 =$ product of number of gravity nodal divisions by number of oscillatory nodal divisions in a linear pendulum; Cfr. Jupiter's mass $= 6\ \pi \times$ Neptune's mass).

27. Struve estimated Sun's proper motion at 1.623 $\times$ Earth's radius vector per annum, which is .258 times Earth's orbital motion, the motions being, therefore, in the ratio of their densities.

28. If we add the orbital motions of Earth and Jupiter, to Sun's proper

Digitized by Google

motion, we obtain, in units of Earth's mean radius vector, Earth, 1.258; Jupiter, .6964. Jupiter's proper motion is, therefore, that which is due the "centre of explosive oscillation," ($\frac{2}{3}$), of which Earth is a limit.

These accordances furnish new data for approximating to the primitive parabolic abscissas of interstellar action. For if we take the kinetic radius $\left[\frac{2\,\pi^2\,r}{\pi^2+4} = 1.4232\,r\right.$ = radius of *mean* velocity of radial, synchronous with with circular, oscillation$\left.\right]$ and the solar modulus limit of possible atmosphere, (35.813 $\times$ radius) as determinants, the three known abscissas (ξ; $\xi + \eta + \zeta$; $\xi + 27\,\eta + 729\,\xi$) give the following logarithms for planetary and stellar abscissas:

		Theoretical.	Perihelion.	Mean.	Aphelion.
ξ = solar radius		.000000		.000000	
$\xi + \eta + \zeta = 1.4232^{\frac{3}{4}}$*		.114950		.114950	
$\frac{3}{4}$ ☿	log. $\xi + 10\,\eta + 100\,\zeta$ =	1.678467	1.680602	1.795038	1.885522
$\frac{1}{2}$ ♀	" $\xi + 11\,\eta + 121\,\zeta$ =	1.910966	1.858650	1.890463	1.920003
$\frac{2}{3}$ ⊕	" $\xi + 12\,\eta + 144\,\zeta$ =	2.155219	2.125604	2.156064	2.184527
$\frac{3}{4}$ ♂	" $\xi + 13\,\eta + 169\,\zeta$ =	2.411227	2.324836	2.390112	2.446847
$\frac{4}{5}$ Asteroid	" $\xi + 14\,\eta + 196\,\zeta$ =	2.678989			
$\frac{5}{6}$ ♃	" $\xi + 15\,\eta + 225\,\zeta$ =	2.958507	2.941956	2.969211	2.994855
$\frac{6}{7}$ ♄	" $\xi + 16\,\eta + 256\,\zeta$ =	3.249779	3.206444	3.244704	3.279865
$\frac{7}{8}$ ♅	" $\xi + 17\,\eta + 289\,\zeta$ =	3.552807	3.521682	3.557093	3.589694
$\frac{6}{7}$ ♆	" $\xi + 18\,\eta + 324\,\zeta$ =	3.867589	3.861415	3.867758	3.873951
35.813 M†	" $\xi + 27\,\eta + 729\,\zeta$ =	7.229595		7.229595	
a Centauri‡	" $\xi + 28\,\eta + 784\,\zeta$ =	7.661925	7.657096		7.686009

We have seen (5) that the limits of the planetary system (Mercury and Neptune), were fixed by the radius of internal rupture and the nucleal radius which correspond to the modulus of light. The values $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, &c., represent the points at which particles falling from $1r$, $2r$, $3r$, &c., would acquire the velocity of central disintegration $(\sqrt{2gr})$. The like co-efficients of Mercury and Mars ($\frac{3}{4}$) seem to indicate satellite relations to Earth and Venus; all the abscissas between Mercury and Neptune, are within the range of orbital eccentricities, the greatest deviations of the theoretical from the mean values being those of Venus and Mars, which are less than five

* The nucleal radius varying as the $\frac{3}{4}$ power of the atmospheric radius. Compare Alexander's ratio for exterior half-planets (*Smithsonian Contributions*, 280, p. 5.)

† Modulus, or the double height of virtual fall which would give the velocity of light, bearing the same ratio to the modular atmosphere, as solar radius bears to solar atmosphere.

‡ The least value is given by Norton; the greatest by Denison. There is no reason for doubting that the true value is between the two.

Digitized by Google

per cent. Jupiter's deviation is about 2.6 per cent.; Saturn's, 1.2 per cent.; Uranus's, 1 per cent.; Earth's, $\frac{1}{3}$ of 1 per cent. The co-efficient-products in the three principal planetary pairs are, ♀ ⊕, $\frac{1}{2} \times \frac{2}{3} = \frac{1}{3}$ = nodal division of linear pendulum; ♃ ♄, $\frac{5}{6} \times \frac{6}{7} = \frac{5}{7}$, nearly $= 2\ r \div$ kinetic radius; ♅ ♆, $\frac{7}{8} \times \frac{8}{7} = 1$. It seems probable that the actual determining orbit was an ellipse, the two foci being within the masses of Sun and *a Centauri*, but the difference between parabolic and elliptical co-ordinates in our planetary system, is not recognizable so near the focus.

Improved Mounted Burettes for Volumetric Analysis.

By J. Blodget Britton.

(*Abstract of remarks made before the American Philosophical Society, December* 3*d*, 1875.)

More than a year ago (meeting of November 20th, 1874, Vol. XIV, No. 93, p. 189, of the published proceedings) I exhibited several burettes mounted on stands, and delicately graduated for close, volumetric analysis, differing from each other, but each having the screw and spring valve adjustment, and also one of the rod-stoppered kind, having the screw and top spring lever adjustment.

I now exhibit and shall explain three others also mounted, and delicately graduated, yet still more improved.

The shortest one (Fig. 1 in the annexed plate), has a capacity of 100 cc, with its scale divided into tenths, or one thousand degrees. The glass rod inside of the tube is operated by means of a thumb-screw (A) which works against a horizontal lever (B) under the stand. The lower end of the light vertical iron rod (C) inside of the wooden upright of the stand, rests upon the front of the lever, and its upper end encircles the glass rod directly under its knob. By turning the thumb-screw, the iron rod, and with it the glass one, may be raised or lowered, and the vent of the burette opened or closed at pleasure. The flow may thus be completely controlled or instantly stopped.

The second instrument (Fig. 2 in the plate) is between four and five feet long, and has a capacity of 240 cc, with its scale divided into tenths or two thousand four hundred degrees. It is operated with the thumb-screw (A) like the shorter instrument from which it differs in construction only in the position of the screw and lever and shape of the latter. The screw is placed

Digitized by Google

Digitized by Google
UNIV. OF MICH.

high up on the upright to allow it to be conveniently grasped when the instrument is being adjusted for use. The eye must at that time be raised to a level with the 0 point of the scale to watch the fluid fall gradually to exactly that point. Should the screw be more than about thirty-four inches below, the hand could not reach it to make the adjustment, its position must therefore depend upon that of the 0 point or length of the instrument.

A short burette should have its thumb-screw placed at or near the bottom of the stand (as shown by Figs. 1 and 3 in the plate) to afford a solid rest for the hand while operating; such a rest will prevent any nervous trembling of the thumb and finger when cautiously shutting off the finishing drop.

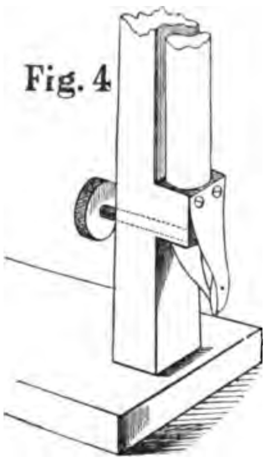
When it becomes necessary to use a strong acid or caustic alkali, and the analytical work is to be done with great accuracy, I believe that these burettes will give full satisfaction. There is no metal or organic substance about them with which the fluid can be affected—nothing but glass. Leaking to any annoying degree does not occur when the rod is not too light and care is taken to exclude from the tube any granular or solid matter that would prevent the rod from shutting down close; the joint must of course be properly ground, and the opening not too large; but should leaking occur regrinding may be done in two or three minutes by dropping into the tube a few grains of emery flour with some water, and then turning the rod sharply round and round, alternately lifting and pressing it a little. It is best, however, not to neglect to make a note of the reading for any length of time after it can be done correctly. The long instrument will be found very serviceable in a laboratory where many consecutive determinations are to be frequently made, for one filling will answer for several, though it is rather cumbersome for only occasional work, and ordinarily the short one will be preferred. They are exhibited together to illustrate the two ways of placing the thumb-screw and lever.

The third instrument (Fig. 3 in the plate) is of the kind I have had in use for about ten years, and with which a great many thousand iron determinations have been made, always working very satisfactorily. Two of them of different patterns were described in the *Journal of the Franklin Institute* for May 1870, and in the London *Chemical News* for July 5th, of same year. The one now exhibited has a capacity of 100 cc, with a delicate graduation, and is about forty-three inches long, the thumb-screw being nearly thirty-three inches from the 0 point of the scale, and near enough to the bottom of the stand to afford a rest for the hand. It has two improvements, one of which is an adjustable plano-convex lens (E) secured by movable joints to a light, metallic frame. The frame is made to slide up and down easily in grooves on the sides of the upright, and has on its right side a vernier. This arrangement permits the scale to be read with extreme precision, and when not required as in ordinary technical work, it may be slid entirely off, and laid aside. The other improvement, which is a minor one, consists of a single, small thumb screw (D) to hold the spring valve (F) in place, while at the same time it allows the valve to be taken off very conveniently when necessary to remove any matter choking the vent,

Digitized by Google

and afterwards to be as conveniently replaced. The old arrangement (Fig. 4) required two screws, for the removal of which a screw driver was necessary. I, however, have not adopted the new to the complete expulsion of the old, which costs but a trifle, and in some respects is excellent.

Fig. 4



NOTES. Each of these burettes, it will be observed, has its graduated scale on white paper firmly pasted against the upright and behind the tube, and not cut on the tube itself; the graduation consequently is as distinct as it is possible to make it, and the reading being *over* the fluid, which affords a *level* to guide the eye, is done with the least liability to error. In this manner the finest of my burettes have been made. When the cutting is on the tube, I prefer it to be behind, and not in front, and well rubbed with lampblack and oil, and have a white paper pasted on the upright for a ground to make it more plainly seen.

Each tube has its lower end drawn out small enough to just allow a stout hog-bristle to pass freely in and out of the vent, and in order that the discharge may be made sufficiently far over into the receiving vessel, it is bent outwards with the point downwards, so that the vent shall be an inch and a half from the upright, and three inches from the bottom of the stand. The rod-stoppered tubes have their points made smooth by fusion, but the spring valved have theirs carefully ground on an emery plate to allow the valves to shut quite true and tight with the line of contact just vertical, and not at an angle.

Unnecessary thickness of glass about the points is avoided, and the valves are made small, especially at their lower ends, to give as little surface of material as possible for the retention by capillary attraction of the dropping fluid. To further obviate such retention, my practice is to occasionally rub the points and valves with a little pure tallow, the effect of which is excellent. Burettes made in the manner described, may with their valves wide open be discharged of 100 cc in about two minutes. But when there is a rapid discharge, a considerable quantity of the fluid is held back on the walls of the tube by attraction, and the quantity so held becomes increased with increased rapidity of discharge; this is shown most distinctly when a strong solution of chameleon is used, for the material gives color to the tube so long as any of it remains. A rapid discharge consequently will not permit a prompt reading, and if the tube be long some minutes must elapse before all of a fluid, of any considerable density, reaches the bottom. The case, however, is different when the discharge is moderately slow and uniform; the reading may then be done usually soon after the reaction has

Digitized by Google

been effected. Against hasty work, therefore, beginners should be specially cautioned, and a slow discharging instrument would be best in their hands

I have experimented in years past, as stated at a former meeting, with valves made of quite a number of substances, hard and soft. Of the hard sort, glass when ground true and cushioned behind, afforded a tighter joint than metal, and gave altogether the most satisfaction, but still with ordinary every day usage would not keep in order, and withstand the pressure of a full column of fluid without leaking more or less. Of the soft sort, rubber and fine grained cork were the best; the latter proved most excellent when solutions of potassium permangenate and bichromate were used. for, while always giving a perfectly tight joint, and being sufficiently durable, it became ***absolutely inert, and never got sticky from applications of tallow*** like rubber. Cork has been in use at the Iron-Masters' Laboratory constantly since 1866, and I still prefer it for my purposes; when cut perfectly true and rubbed with tallow, it will make a valve from which globules no larger than the head of an ordinary pin can be discharged at will. I attach it to the spring with a rivet, and sometimes with a cement; for attaching thin rubber I have used a cement and also a benzine solution of rubber. For springs I have used platinum, brass, steel, and common tin plate.

Of the instruments exhibited, the rod-stoppered kind have the advantage of universal application, but the spring valved kind have more solidity and compactness, and will bear much rougher usage.

The one described by George A. Kœnig, Ph. D (Vol. XIV, No. 93, p. 218, of the published proceedings) is the short, graduated tube furnished by the dealers. to which is fitted the thumb-screw, and spring valve adjustment, the screw working through the spring, and not against it. It is not permanently mounted, and must be used like the one long ago proposed by Mohr (See side view Fig. 5). He states that by putting a hinged joint to the spring he has been enabled to use a platinum valve with a 30 cc tube, the delicacy of the hinge though, was found to be an objection, making the valve liable to get out of order. He further states that a spring coated with rubber will resist the action of standard acids. The instrument is substantially what had been produced years before, and, as must be obvious, is not so perfect as the permanently mounted one.

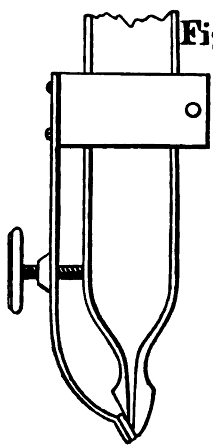


Fig. 5

Stated Meeting, February 4th, 1876.

Present, 17 members.

Vice-President, Mr. FRALEY, in the Chair.

Letters of envoy were received from the Botanical Gardens, at St. Petersburg, December 19th, 1875, and from the Albany Institute, January 28th, 1876.

Letters of acknowledgment were received from the New Bedford Public Library, 93,94; New York Historical Society, 95; and Rantoul Literary Society.

Donations for the Library were received from the Asiatic Society, Japan Branch; R. Academy, at Brussels; Royal Astronomical Society, in London; London Nature; Peabody Academy at Salem; Boston Society of N. H.; Mr. Edmund Quincy; American Journal of Science, and Professor Marsh, of New Haven; Albany Institute; Society of N. S. Buffalo; American Pharmaceutical Association; A. Journal of Pharmacy; Penn Monthly; Medical News; Social Science Association at Philadelphia; and U. S. Department Interior.

The death of John C. Cresson, first Vice-President of the Society, was announced by Mr. Eli K. Price, as having taken place January 27th ult., aged 69 (born March 16th, 1807).

On motion of Mr. Price, Mr. Fraley was appointed to prepare an obituary notice of the deceased.

Prof. Hart made a statement of the arguments for and against the genuineness of the "Death Mask of Shakespeare" said to have been discovered in Germany, illustrating his remarks by photographs of the principal portraits of Shakespeare, and of the mask in different positions.

Mr. Chase made reference to the paper of Dr. D. Ast, in the American Journal of Science and Arts for January, 1854, reproduced in the American Chemist for May, 1875, on observations on the spectra of metals in the electric circuit.

Pending nomination No. 792 was read.

Digitized by Google

Mr. Fraley reported the receipt of $150.40, the dividend from the Michaux legacy last due, January 1st, 1876.

Mr. Blodget, on behalf of the Committee appointed at the last meeting, made a preliminary report, and the meeting was adjourned.

Stated Meeting, February 18th, 1876.

Present, 13 members.

Vice-President, Mr. Fraley, in the Chair.

A letter accepting membership was received from Dr. J. Gibbons Hunt, dated Philadelphia, February 4th, 1876.

A letter respecting the action of the Society on the subject of the Polaris Expedition was received from Admiral Davis, dated Washington, February 15th, 1876.

A letter respecting a coin of 1670, the date of the settlement of Quebec, struck by order of Louis XIV, and making the first currency of French North America, was received from Prof. Charles E. Anthon, dated, College of the City of New York, February 11th, 1876, desiring to learn whether the Society would accept the coin, and place a record of its character in their Proceedings.

A letter of envoy was received from the U. S. Naval Observatory at Washington.

Letters of acknowledgment were received from the R. Danish Academy, January 15th (XVII. 93, 94); Essex Institution, February 5th (95); Boston N. H. S. (95; and asking for Vol. V, N. S. and 94); and the U. S. Naval Observatory, February 4th (95).

Donations for the Library were received from the Society at Dresden; the Geographical Society at Paris; the Editors of the Revue Politique; Nouvelles Météorologiques; Revue Philosophique; and Revue Historique; the British Association; Geological, and Meteorological Societies; Nature; Mr. Sam. Birch of the British Museum; Liverpool L. and P. Society; Franklin Institute; Medical News; Prof. E. J. Houston; and U. S. Naval Observatory.

Digitized by Google

The Committee on Dr. Valentini's memoir was continued.

The death of Mr. Charles des Moulins, at Bordeaux, on the 23d December, 1875, was announced by letter.

Mr. Blasius read a defense of his theory of storms.

A Brief Discussion of Some Opinions in Meteorology.

By W. Blasius.

Read before the American Philosophical Society, February 18th, 1876.

The definite establishment of the laws which regulate the weather is of so much general importance that I am induced to ask your attention to the following remarks, since the discussion of opinions cannot fail to elaborate the truth at last.

In the January number of the Atlantic Monthly, there appeared a fair-tempered review of my recent work on "Storms," which seems to be from the pen of a practical meteorologist, between whom and myself, therefore, I am the more anxious that there should be no misunderstandings. The reviewer does not deny nor admit the truth of the theories I have advanced, but leaves them to the verdict of time.

He in some important particulars, however, fails to understand the views I hold. Permit me to quote:

"The West Cambridge Tornado, which first decided the direction of our author's meteorlogical studies, seems to have had a too powerful influence upon his judgment of the 'cyclonists,' the upholders of Redfield's Theory. Where a cyclonist sees a large storm 500 miles in diameter, on the borders of which the winds are blowing in every direction, Dr. Blasius sees many small storms, each modeled in a greater or less degree like the West Cambridge Tornado. A very striking proof that a storm may be constituted as the cyclones are supposed to be is afforded by the singular case of the ship Charles Heddle, which was caught in the borders of one of these cyclones, and sailed five times completely around its border, meeting winds blowing exactly in the directions demanded by the cyclone theory. The experience of Dr. Blasius has been limited to local storms, and he has apparently never been able to realize the existence of a storm of any magnitude.

This is particularly evident in the discussion of Prof. Abbe's report on the Nova Scotia storm of August 23, 1873. Prof. Abbe is speaking of a storm at least 500 miles in diameter, but Dr. Blasius discusses it as if it were an assemblage of tornadoes each 1,200 feet wide."

Now the statement that where "a cyclonist sees large storms," I see "many small storms" is curious enough, since a considerable part of my

Digitized by Google

book is devoted to an attempt to prove that in many cases where the U. S. Signal Service and other cyclonists see "many small storms," each independent of the other, there is in reality one large storm hundreds of miles in width.

And as for the fact that "a storm may be constituted as the cyclones are supposed to be," the position I have taken is not that there are *no* cyclones, but that there are none in our latitude, and that the theory which would make all storms cyclones is radically erroneous. The citation of the Charles Heddle case, to which I have also alluded in my book, is not a very fortunate one, however, since it is far from being authentic. Even Dove himself, the great apostle of the cyclonic theory, calls it a "sea romance," "oder auf gut muselmænnisch gesprochen, etwas was gesehehen sein kœnne, wenn es dem Propheten so gefallen hætte."

Even if it were authentic, however, it would not conflict with any position I have taken, since the storm to which it relates was a typhoon of the Indian Ocean.

The complaint that my experience has been limited to local storms, shows some confusion of ideas, since it is not to be supposed that extensive storms have avoided me, or that the researches of others are not open to me. The reviewer in another place says:

"If Dr. Blasius's book were not dated from the Atlantic coast, the meteorologist could yet determine quite accurately his latitude and longitude from the types of storms he gives."

This is quite satisfactory, since the professed aim of my book is to give general principles, capable of universal application, and then to show how these principles are applied to our latitude as example of the modifying effect of differing local circumstances. Meteorology is largely a science of locality, after all, as well as of the air; mountains, lakes, forests, the sea—all have their effect in determining how the general weather changes will affect us. And this is the reason why predictions for a large section of country, such as the signal service give can never be so accurate as to be of much use.

That I have endeavored to show how general principles could be locally applied, probably affords the Atlantic Monthly reviewer ground for supposing my views restricted; but he cannot have read the book very carefully. So far from not being able "to realize the existence of a storm of any magnitude," it is one of the main points of difference between the cyclonists and myself that, whereas they consider the area of low barometer *the* storm, my views make this but a part of the storm, which covers also much larger areas of high barometer in front and rear.

The particular case cited, that of the Nova Scotia storm of August 23, 1873, is not at all to the point, since, instead of taking a more limited view of the phenomenon than Professor Abbe does, I hold that the storm was twice as large as Prof. Abbe supposes it to have been, and that one-half of it the Signal Service never knew at all. More than this, the half they did not see was that which was on land within their jurisdiction, and was the real

cause of most of the tremendous destruction that occurred. The Signal Service maps of this storm merely note an "area of high barometer" coming from Manitoba on the 22d, to which they attach no significance, and which they do not connect with the Nova Scotia storm; but I feel convinced that this very same "area of high barometer" really an advance of heavy air from the North, was responsible for the loss of most of the thousand and odd vessels that were destroyed on the coast. If the Signal Service had only known its true character, they would have been able to give, at least a day ahead, forewarnings of this most terrible storm which, as it was, took them entirely unawares.

In these "areas of high barometer" the cyclonists see an inexplicable something which they call an "anti-cyclone;" in which they think the air rotates in the opposite direction from that in a cyclone, and that it brings dry and fair weather. The celebrated Le Verrier, acting on this theory, on account of the advance of such an "area of high barometer" over England, predicted fair weather just before those violent storms and terrible floods which last Summer desolated so large a tract of country in France. The theory which I hold would have shown him in this "area of high barometer" an advance of the polar current, almost certain in the Summer season to produce violent rains. It was much the same case with the Nova Scotia storm.

As for the statement that I have discussed this storm as if it were "an assemblage of tornadoes," (*sic*) I do not see any evidence of a tornado at all. A tornado is only a local incident—although a terrible one—in the passage of a Southeast storm, caused principally by the configuration of the ground, notwithstanding that the Signal Service describes one as "at least thirty miles," and "probably 240 miles" in diameter.

The Atlantic reviewer states that, "as a matter of fact, the Signal Service notes all storms within the limits of the Atlantic coast and the Rocky Mountains," and "its object is to obtain the laws of them as they exist." In my book I have pointed out several instances where the advance of the polar current, producing a Southeast storm of considerable magnitude is treated by the Signal Service as a series of detached local storms, such as tornadoes, hail-storms, cloud-bursts, etc., of which they know nothing until they are over; cases of this kind are abundant in the Signal Service reports. If the object of the Signal Service is to establish laws, why—I ask it in no hostile spirit—has it as yet given no laws to science? Or why does it, as the New York *Nation* lately says, "Keep as widely as possible aloof from the science of the country?"

I have also protested against the practice of observing only at fixed hours of the day, contending that if an individual storm is to be known, it must be observed continuously so long as it lasts. The Atlantic reviewer thinks it is not necessary for the Signal Service to do this, because "these (continuous observations) are easily accessible in the quarterly reports of the meteorological office of England!" Upon this method, if you wish to know what are the distinctive characteristics of an African elephant, all you have

Digitized by Google

to do is to get some one's description of an Asiatic elephant, and draw your own conclusions. Mr. F. Gaster, of the London Meteorological Office says upon this point, that at Valentia, where observations are not made between the hours of 8 A. M. and 2 P. M. "Storms have been overlooked, which would doubtless have been noticed at the Central Office, where the weather is observed continuously." Is it not at the least very probable that the Signal Service, making but tri-daily observations, has overlooked storms in the same way?

In my book I urge that observations of the clouds *in connection* with ærial currents is of the greatest importance, which the Atlantic Monthly writer attempts to meet by saying that the Signal Service has made tri-daily maps of the clouds for four years. This may be true, but it has never made observations of the intimate connection of the clouds with ærial currents, nor understood this significances. Early in 1874 I explained my views to Prof. Henry of the Smithsonian Institute, in a personal interview, and he then said, "This is all new to me." He took copious notes. The Signal Service report for 1873, published after this, contains a few old plates of the cloudforms given by Howard, Pœy, and others, but with no reference to them in the text. That of 1874 contains cloud maps for one day, with no reference in the text, and contains no attempt to give the particular forms any distinctive character. The eminent meteorologist, Prof. H. Mohn, Director of the Royal Meteorological Institute at Christiania, Norway, in a letter to me says: "That you *introduce* the cloudforms into practical meteorology is certainly very good." It is of little use to make maps of the clouds unless we understand something of their significance.

The reviewer states that I claim for myself in conjunction with ex-President Hill, of Harvard, "the credit of originating the present Signal Service storm-warnings," but that we "were anticipated by Redfield, Henry, and others." A claim of this kind is hardly worth advancing or discussing, but I wish to correct misunderstandings. All I do claim is that in 1851, before any one else, I believe, I advocated and labored for a corps of meteorological observers connected by telegraph with a central office, so that the central observer might see the whole storm continuously in all its extent from beginning to end.

I would earnestly urge a popular interest in meteorology, since no other science is so open to those occupied in other pursuits, and scarcely another of so much practical importance. We all know men of no scientific acquirements, yet who are so well versed in signs of the weather that their predictions are more to be relied on for a particular locality than the very general "Probabilities" of the Signal Service. Such weather-wisdom is founded upon accurate observations of nature, and the explanation of weather signs is often very simple. For instance, it is an old Indian observation that Summer storms follow the course of rivers. The explanation of which is that Summer storms are mostly produced by the advance of colder air, which being heavier, sinks into and follows the valleys, at the bottom of which there is usually a water-course. Again, a halo round

Digitized by Google

the moon indicates rain, since its cause is the partial obscuration of the moon by the first hazy clouds of an approaching Northeast storm. With a knowledge of the connection between the clouds and movements of the air, it will be comparatively easy for any one to predict for his own locality the weather he is to expect from day to day. That this is practicable, is proved by the experience of many, and by an able article on the subject in the Galaxy Magazine for November, by Mr. F. Whittaker.

In connection with the importance of clouds in practical meteorology is the following statement in the scientific record of Harper's Monthly for August, 1875, edited, I believe, by Prof. Spencer F. Baird, of Washington.

"Dr. Hildebrandsson, of Upsala, has published the results of a careful study of observations of cirrus clouds. Having secured by personal correspondence a number of careful observers throughout Europe, he has compared the observed movements of cirri with the prevailing clouds and isobars at the surface of the earth. He finds that the cirrus clouds, in a large majority of cases, flow *out* from areas of *low* barometer, and *in* toward areas of high pressure, and, as he succinctly expresses it, the movement of these clouds is toward a point some distance to the right of that toward which the lower clouds move. We had occasion, a few years ago, to announce precisely the same law, as deduced by Prof. Abbe for the United States. It would seem, therefore, a law applicable to the whole of the northern temperate zone, and is entirely in accordance with the mechanical theory developed by Mr. Ferrel in a memoir published in 1860."

The same fact is referred to in Harper's Weekly, January 15, 1876, as follows: "Clement Ley so well known by his investigations into the movements of storms, states, in reference to the movements of cirrus clouds, whose laws have been investigated by Hildebrandsson and others, that his own observations fully confirm those of the latter as to the motion of the upper clouds, with only this modification, that the vertical axis of a revolving storm, about which the whole mass of air may be supposed to rotate is not exactly vertical, but inclined backward."

The writer evidently considers this isolated fact a very important discovery, and it really is the first attempt on the part of the cyclonists to consider the motion of clouds as well as their forms, and I might almost say the first step towards bringing the clouds into connection with storms.

As the cyclonists see the storm in the "area of low barometer," and the opposite of the storm in the "area of high barometer" their "*anti*-cyclone," it is natural that they should describe the motion of cirrus clouds in relation to these phenomena. But as the origin and nature of these phenomena are as yet unknown to them, the cause of the motion of the cirrus clouds in the direction described remains also unknown, and forms thus another puzzle besides the many we have already in the science.

As to the precedency in the discovery of the fact in question, I would draw your attention to my article—"New Theory of Storms," in the New York Times, November 18, 1852, reprinted and more fully elaborated in my recently published work—"Storms, their Nature, Classification and

Digitized by Google

Laws." It will be seen from this article that I observed the fact as to the motion of cirrus clouds besides others of a like nature about a quarter of a century ago, lectured on it publicly and published it. Copies of the article were sent to Prof. Henry and Lieutenant Maury in Washington. This article which was a sketchy summary of my investigations, contains also the laws of the motions of the lower cloudforms, such as cumulus, cumulo-stratus, conus. And it contains not only the laws as to the direction the different cloudforms take, but also an explanation of the causes of their motion, and the application to the prediction of storms. I mention these facts to show the overpowering influence of recognized authority in accelerating or retarding the development of a Science. Truth of the greatest importance often remains unnoticed if it does not pass first from the lips of a well-known authority, and errors may be propagated for centuries under the shadow of a great name. Although late, it is gratifying, however, to see my observations confirmed as the heavy train of Science moves onward.

Another reason why my observations have remained unnoticed so long, may also be found in the circumstance that I have seen and described meteorological phenomena from a different standpoint from that generally taken. A circular ring will appear to one as a straight line, to another as an ellipse, and to a third one as that what it really is, according to the standpoint from which it is viewed. This is very apparent in looking at phenomena the whole of which we cannot see at once, such as the motions of heavenly bodies or storms; we then are likely to take things as they appear to be. So men thought for centuries that the sun moves and the earth stands still, and the cyclonists think even now that the wind in a storm moves around in a circle, or in an ellipse, or in a spiral, because it appears so. They see in the "area of low barometer" the whole storm, while I from my standpoint see in it only the effect of the storm. The cyclonists see in the areas of *low* and *high* barometer independent although unexplained phenomena; to me these phenomena appear to belong together as organic parts of the storm and assume thus a meaning. With me a progressive storm consists in the displacement of one of two opposing air currents by the other, which is of different temperature, and the area of low barometer forms itself during this conflict between them by the rising of the warmer current obliquely over the colder one. The rising air produces lower pressure, but the full weight of each current produces the areas of high barometer in front, and in the rear of the area of low barometer. I, therefore, see the storm extend over much larger area than the cyclonists do.

I see in the ærial currents the elements of the storm, the cyclonists seem to consider them as the consequence of the storm. I, therefore, naturally consider the motion of the different cloudforms in reference to the ærial currents, and not in reference to barometric pressure, but the facts of their motion are and remain the same.

The "cirro stratus" of Howard—in fact all cirrus clouds—move with the

Digitized by Google

warm equatorial current, because they are originated by it as it ascends into colder regions obliquely over the colder polar current. The "cirro-stratus" I described in the Times article in 1852 as the embodiment of a fully developed north-east storm, because I found it characteristic by my observations of an approaching equatorial, warm current. I, therefore, consider it an elementary form, and proposed the single name "stratus," used by Howard hitherto for ground fog, which I consider of no form. The name "stratus" admirably indicates the stretched-out, straight-line cloud; it represents with my two other elementary forms—cumulus, conus—geometrical forms and is therefore easily described. The other forms of cirrus, commonly known as mare's tails, cat's tails, etc., are mere modifications of the stratus (cirro-stratus of Howard) forming during the first irregular attempts of the rising warm current before it has assumed its regular lateral motion in which the cirrus forms assume that of the stratus at the top of the regular front waves. We therefore see "the cirrus clouds flow out from areas of low barometer" (the place of the obliquely rising warm current) "and *in* toward areas of high pressure" (the colder polar current). My article twenty-four years ago, therefore, tells not only the facts about the motion of cirrus cloud which Hildebrandsson, Ley and Abbe have recently observed, but also the cause. Besides this it contains the practical application to predict from the appearance of these clouds above the southern horizon the coming of the equatorial current, or the approach of a north-east storm. While thus from the standpoint of the cyclonists the cause of the empirical fact cannot be explained, it follows as a natural consequence when seen from the standpoint I have taken.

The article in question contains also the laws of the motion of lower cloudforms, such as the cumulus, cumulo-stratus, and conus, and why they take their respective course, and how the movement and condition of the currents of which they are characteristic, i. e., the storm may be predicted by their appearance. The study of cloudforms *in connection with ærial currents* is one of the most important duties of practical meteorology.

As to Clement Ley's proposition, "that the vertical axis of a supposed revolving column of air is not exactly vertical, but inclined backwards," I would call your attention to a third opinion held by some most eminent meteorologists, such as Dove, Reid and Redfield, that the axis is inclined forward. The cyclonists run here again into a fresh contradiction, and create a new puzzle, some saying the axis lies forward, some it lies backward, and others it is vertical. It reminds us of Redfield and Espy's discussions, where one maintained that the wind in a tornado moves around in a circle, the other that it blows in straight lines toward the centre. These discrepancies are a consequence of the mode of investigation universally followed in this science, which is to deduce results from a conglomerate mass of disconnected data, obtained indiscriminately from storms that may differ as widely in origin and character as a bat and a sparrow. What have we gained towards an individual knowledge of either the bat or the sparrow by eliminating from a number of data the mean velocity and the

Digitized by Google

average direction of their flight? We mix things that do not belong together and arrive at best at indefinite, vague and unreliable results. This evidently has happened in determining the direction of the axis of a supposed revolving column of air.

The discrepant views of the celebrated meteorologists above mentioned, will all harmonize if considered from the standpoint indicated in my recent work. The supposed revolving column of air is seen from my standpoint as the obliquely rising equatorial, or warm current; its direction always inclines towards the north, or colder region. It thus coincides with the position of the axis of the supposed revolving column; in a north-east storm it is inclined forward, in a south-east storm backward, in a local storm it is vertical. The method of averaging will lead to the first result if the cases subjected to investigation belong all or in the majority to north-east storms; it will lead to the second result if the cases subjected to investigation belong in the majority to south-east storms; it will bring no result, or make the axis vertical if the cases or data subjected contain a number of both kinds in equal proportions.

Mr. Blodget remarked that there were very striking and valuable suggestions in Mr. Blasius' paper.

He thought that it was true that the influence of the Signal Service was in danger of being weakened by its persistent observations of only three hours in the day. Storms require observation continuously during their course. He agreed with Mr. Blasius, also, in accounting of inferior values other elements of the discussion of storms, those areas of low and high barometer which almost exclusively occupy the S.S. maps. He described the remarkable storms of 1873, accompanied with disastrous floods. They were not parts of a common storm usual to the Temperate Zone, raining from the lower portions of the atmosphere coming from the Gulf; but on the contrary, they were numerous local furious downpours from a hot supersaturated upper air coming from some more distant, unknown region in the South. They had the characteristics of tropical storms, and were so local, that in some instances a distance of only twenty miles sufficed to distinguish a flooded locality from one on which no rain fell. Mr. Blodget added, that, having in former years participated in the discussion of Espy, Redfield and Hare, he could meet the vertical theory with an expressed conviction of the impossibility, quite demonstrable, that a large storm should rotate upon the rough surface of the earth; although it must of course remain true that any disturbance in fluids has a tendency to set up vertical movements. The vast obstructive friction of the face of a country in the case of great air movements must always prevent any rotation over wide areas. Local tornadoes may produce small whirlwinds, but a Redfield cyclone is a physical impossibility. He had found in Mr. Blasius' book more of a true explanation of the origin and progress of storms than elsewhere. While Mr. Blasius had proposed the Signal Service system in 1851, he had himself used the telegraph in the Summer of 1852 for two months; and his charts

Digitized by Google

of that date show that he proved thereby, and then, the practicability of precisely determining the form and limits of any storm. All that he asked of the Signal Service now was to make continuous observations, instead of three observations a day, and to put down upon their charts the other more important elements with that of barometric pressure.

Prof. Houston noticed the fact that, by the barometer at the High School, the mercury stood, on the 5th of February at 1.20 P. M., at the most extraordinary height of 30.94. He wished also to put on record his proposed improvement of the barometer, at the mechanical details of which he is now working, viz: to read with greater ease and precision, by means of a scale floated on the surface of the mercury, counterbalanced and connected with a ring around the tube.

Prof. Sadtler, by permission of the Geological Survey of Pennsylvania, gave the scientific results of his recent analyses of gas from several oil wells in Western Pennsylvania—gas which is used in the iron manufacture.

CONTRIBUTIONS FROM THE LABORATORY OF THE UNIVERSITY OF PENNSYLVANIA.

No. VI.

On the Composition of the Natural Gas from certain Wells in Western Pennsylvania.

By Samuel P. Sadtler.

(*Read before the American Philosophical Society, Feb.* 18, 1876.)

Having had occasion lately to analyse some of the gases issuing from wells in Western Pennsylvania, I have obtained some results which are given as a contribution to our knowledge of these important natural products. There have been almost no analyses whatever made of these gases. In 1866 a French geologist, M. Foncou visited a number of these gas-wells and collected specimens of the gases. These were afterwards analysed by M. Fonqué, and the results are published in *Compt. rendus LXVII. p.* 1045. The localities were Pioneer Run, Venango Co., Pa.; Fredonia, N. Y.; Roger's Gulch, Wirt Co., W. Va.; Burning Springs, on the Niagara river below the Cataract; and Petrolia, Enniskillen district, Canada West. These points are certainly widely enough removed to make the series comprehensive from a geological standpoint. The analyses do not appear to have been complete ones, as M. Fonqué determined the exact amounts of only a few of the constituents. In general, the gases were composed of

Digitized by Google

members of the marsh-gas series of hydrocarbons. Thus the gas from Pioneer Run he found to have essentially the composition of propyl hydride ($C_3 H_8$), with small quantities of carbonic acid and of nitrogen; the Fredonia gas appeared to be a mixture of marsh-gas (CH_4) and ethyl hydride ($C_2 H_6$), with a small quantity of carbonic acid and 1.55 per cent. of nitrogen; the Rogers' Gulch gas was CH_4 almost exclusively, with 15.86 per cent. of carbonic acid, and a small quantity of nitrogen; the Burning Springs gas almost pure CH_4 with a little CO_2; the Petrolia gas a mixture of marsh-gas (CH_4) and ethyl hydride ($C_2 H_6$), with a small amount of carbonic acid.

However, in some cases the composition as given above was only apparent, as in the case of the Pioneer Run gas, for on passing the gas through alcohol a part was absorbed, which was afterwards shown to be butyl hydride ($C_4 H_{10}$), while the part unabsorbed showed nearly the composition of marsh gas (CH_4). It was evident, therefore, that what appeared to be propyl hydride ($C_3 H_8$) was in reality a mixture of marsh-gas (CH_4) and butyl hydride ($C_4 H_{10}$).

In 1870, Prof. Henry Wurtz made an analysis of the gas from a well in West Bloomfield, N. Y. The results of this analysis are found in *Silliman's Journal* (2) *XLIX.*, *p.* 336. He found:

Marsh-gas	82.41
Carbonic acid	10.11
Nitrogen	4.31
Oxygen	0.23
Illuminating hydrocarbons	2.94
	100.00

The specific gravity of the gas was .693.

The methods of analysis were not the usual ones of gas-analysis, but some new absorption methods devised by himself in conjunction with Prof. B. Silliman. This, I believe, is the extent of the published information on the subject.

The gases which I collected and analyzed were:

First, the gas of the Burns Well in Butler County; secondly, that of the Harvey Well in the same county; thirdly, that from the Leechburg Well across the Kiskeminitis river from Leechburg, in Westmoreland County and fourthly, the gas bubbling from a spring at Cherry Tree in Indiana County. As the results of Fonqué just given had rendered the presence of higher members of the marsh-gas series than CH_4 probable, at two of these wells, I made, in addition, absorption tests with absolute alcohol and with bromine, hoping to prove qualitatively the presence or absence of these higher hydrocarbons as well as those of the ethylene series. For while marsh-gas itself is insoluble in absolute alcohol, ethyl hydride ($C_2 H_6$) is dissolved to the extent of $1\frac{1}{2}$ volumes, propyl hydride ($C_3 H_8$) to the extent of 6 volumes, and butyl hydride ($C_4 H_{10}$) to the extent of 18 volumes in one volume of the alcohol. A pas-

Digitized by Google

sage of the natural gas for 15 or 20 minutes, therefore, should saturate the alcohol with such of these hydrocarbons as might be present. The bromine absorption test was made in order to ascertain whether any ethylene or butylene dibromide would be formed by the passage of gas.

The gases tested in this way were the gas from the Burns Well and gas from the Leechburg Well. The bottles containing the alcohol, having been tightly stoppered and sealed at the time, were afterwards examined in the Laboratory. The Burns Well gas was first examined. The alcohol through which the gas had been passed was transferred to a small flask, and enough additional alcohol was added to completely fill the flask. A cork perforated and carrying a delivery tube was then fitted to it so that the excess of alcohol filled this tube also.

The flask was now heated, and the gas given off was collected in a eudiometer tube over warm water. I obtained thus some 150 cubic centimeters of gas. The operation was pushed until only alcohol vapor was given off, which was absorbed by the water. To the gas in the eudiometer I then added rapidly an equal volume of chlorine, and allowed it to stand exposed to diffused sunlight. Oily drops formed at once, while the volume of the gas contracted until it occupied only about one-half of the first volume.

This showed the probable formation of ethyl chloride ($C_2 H_5 Cl$) which is gaseous at temperatures over 12°C, and of either propyl chloride ($C_3 H_7 Cl$) which is liquid at temperatures under 52° C, or of butyl chloride ($C_4 H_9 Cl$) which is liquid at temperatures under 77.6° C. On inverting and applying a flame to the gas in the eudiometer, it was found to be inflammable, burning with the greenish flame characteristic of ethyl chloride. The water upon which the oily drops had collected, was put in a small flask, and an attempt was made to separate them by distillation. This was however, unsatisfactory, as there could only have been small quantities of either propyl chloride or butyl chloride. The water in the endiometer tube reacted acid from the H Cl formed.

The result of these tests may therefore be summed up as showing the certain presence in the gas of ethyl hydride ($C_2 H_6$) and the probable presence of either $C_3 H_8$ or $C_4 H_{10}$.

The qualitative examination of the Leechburg gas was made in the same way. I obtained here only about 100 cubic centimeters of gas on heating the alcohol. On mixing with chlorine a contraction of about one-third took place. The inflammability of the residual gas and the formation of oily drops gave the same indications as with the other gas.

The other qualitative tests were with bromine. This had been tightly bottled and sealed up. The bromine from the test with the Burns gas was then placed in a porcelain dish and water added. Pure sodic hydrate was added to neutralize the excess of bromine. The sodium bromide formed dissolved at once in the water. There remained no trace of oily drops such as would be caused by the bromides of the olefine series of hydrocarbons. The sodium bromide was afterwards crystallized out perfectly pure. The test was therefore entirely negative in its results.

Digitized by Google

On examining the bromine used for absorption with the Leechburg gas, there was apparently a slight layer upon the surface of the bromine, which might have been ethylene bromide. On neutralizing the excess of bromine, however, no distinct evidence could be had of the presence of the bromide, so that the result was left uncertain.

The quantitative analyses were next made. In these the carbonic acid, carbonic oxide, illuminating hydrocarbons, and free oxygen were tested for and when present removed by suitable absorption re-agents, while the hydrogen, marsh-gas and ethyl hydride were determined by the eudiometer analysis. Any nitrogen present remains over and is estimated at the conclusion of the analysis.

Burns Well Gas (average of two analyses).

Carbonic Acid	.34
Carbonic oxide	trace
Illuminating hydrocarbons ($C^n H_{2n}$)	——
Hydrogen	6.10
Marsh-gas (CH_4)	75.44
Ethyl-hydride ($C_2 H_6$)	18.12
Propyl-hydride ($C_3 H_8$)	trace
Oxygen	——
Nitrogen	——
	100.00

Leechburg Gas (average of two analyses).

Carbonic acid	.35
Carbonic oxide	.26
Illuminating hydrocarbons ($C_n H_{2n}$)	.56
Hydrogen	4.79
Marsh-gas	89.65
Ethyl-hydride	4.39
Propyl-hydride	trace
Oxygen	——
Nitrogen	——
	100.00

Harvey Well Gas.

Carbonic acid	.66
Carbonic oxide	trace
Illuminating hydrocarbons	——
Hydrogen	13.50
Marsh-gas	80.11
Ethyl-hydride	5.72
Propyl-hydride	trace
Oxygen	——
Nitrogen	——
	99.99

Digitized by Google

Cherry Tree Gas (average of two analyses).

Carbonic acid	2.28
Carbonic oxide	——
Illuminating hydrocarbons	——
Hydrogen	22.50
Marsh-gas	60.27
Ethyl-hydride	6.80
Oxygen	.83
Nitrogen	7.32
	100.00

It will be seen that the first three of the gases just analyzed are very similar in composition, while the gas escaping from the spring at Cherry Tree differs very considerably from the others. The larger amount of carbonic acid and the presence of free oxygen and nitrogen are the chief points which distinguish it. It is only natural, however, that a gas escaping from fresh spring water should contain these gases, as they are the gases usually dissolved in spring water. As to the other constituents of these gases, hydrogen, marsh-gas, and ethyl hydride are the most important ones. In the case of two of the gases, the Burns gas and the Leechburg gas, qualitative tests directly proved the presence of this last constituent. The other two ingredients can also be proved to be there by the application of Bunsen's formulas to the result of the eudiometric analysis. Thus, as the volume of gas taken for the eudiometric analysis can contain only hydrogen, hydrocarbons of the marsh-gas series and nitrogen, we need for our formulas four known values; the volume taken, the contraction after passage of the spark, the carbonic acid produced by the combustion and the free nitrogen in the sample of gas taken.

In the three gases first analyzed this last constituent proved to be absent, so that we had only three values, and could form only three equations, containing three unknown quantities. These equations were:

$$x + y + z = V. \ (1).$$
$$y + 2z = C. \ (2).$$
$$3x + 2y + \frac{5}{2z} = A. \ (3).$$

where V equals the volume taken, C the carbonic acid formed, and A the absorption or contraction, consequent upon the explosion, where also x was taken as hydrogen (H), y was taken as marsh-gas (CH_4), and z was taken as ethyl-hydride (C_2H_6). When in these equations were substituted the found values of C and A, I got plus values for x, y, and z. On the other hand, if I assumed two constituents only, x as hydrogen and y as marsh-gas, the y was made equal to C at once, which was obviously incorrect, and would have given a minus value to x. If again, I assumed x to be equal to CH_4, and y equal to C_2H_6, I got false values for x and y. One other assumption only was open to me, that was to take x as hydrogen, y as marsh-gas (CH_4), and z as propyl hydride (C_3H_8). This would have given

Digitized by Google

plus values for x, y, and z, but the previous qualitative tests had shown conclusively the presence of $C_2 H_6$.

I found, however, unexpectedly in Fonqué's memoir the strongest confirmation of my interpretation of my results. Using the three equations that I have given above, he finds that when x, y, and z represent three successive members of the marsh-gas series, the equations are as follows:

$$x + y + z = V. \quad (1).$$

$$x + 2y + 3z = C. \quad (2).$$

$$2x + \frac{5}{2y} + 3z = A. \quad (3).$$

from which can be deduced as a fourth equation.

$$2A - 3V = C. \quad (4).$$

In other words, when an eudiometric analysis of a mixture of hydrocarbons of the marsh-gas series is made, the carbonic acid formed is equal to twice the contraction, minus three times the volume of gas taken.

He says, therefore, (*Compt. rendus.* LXVII. p. 1048) when the marsh-gas hydrocarbons are mixed with free hydrogen, this fourth equation is not realized. I did not find it realized in any of my analyses. Thus in the analyses of the Burns Well gas, I had the following figures:

	I.	II.
Gas taken	32.74	24.49
Contraction	70.4	52.75
CO_2 absorbed	36.6	27.5

If we substituted the values of C and V as found, in the formula $2A = C + 3V$, we get, for the first, $36.6 + 98.22 = 134.82$, of which the half is 67.41. But the observed contraction is 70.4, or 2.99 greater than that demanded by Fongué's formula for the marsh-gas hydrocarbons. So for the second we get $27.5 + 73.47 = 100.97$, of which the half is 50.485, while the observed contraction is 52.75.

If now we turn to to the formulas first stated by me, we find the explanation in the third equation where we have $3x$, assuming x to be hydrogen; and in the second equation where we have $0x$, assuming x to be hydrogen.

I have not been able as yet to make any experimental determinations of the specific gravity of these gases, but have the material reserved, and expect to do so. The specific gravities as calculated from the analyses given, are as follows:

	Sp. gr.
Burns Well gas	.6148

Mr. Lesley mentioned that Mr. Hall had found three casts of an *Orthis* of the Trenton (Bala) Limestone in a subangular fragment among the moraine (?) matter cut into for a drain in front of the University buildings in West Philadelphia.

Digitized by Google

Mr. McArthur presented through Mr. Walter nine photographs of models of ornaments for the Public Buildings.

Pending nomination No. 791 and new nomination No. 792 were read.

The minutes of the last meeting of the Board of Officers and Council were read.

Mr. Blodget, from the Committee on the Progress of Science Exhibition at the Centennial, reported that his Committee had met, and would act with a committee appointed by the Acad. Nat. Science, Phila. (Dr. Le Conte, Mr. C. E. Smith, Mr. W. Vaux), and he read a paper expressing the views of the joint committee, and explained that a room 24′ by 48′ in the southeast end of the Main Building, up-stairs, had been appropriated by the Commission to their use, and there was good reason to believe that learned Societies would respond cordially enough to fill this room.

Prof. Campbell disclaimed for the Commission all responsibility, except for guaranteeing the right of placing whatever it saw fit in this room by the joint committee.

Prof. Fraley said that an application would be made to the Society for permission to exhibit its Elliot Bible.

There being no other business, the meeting adjourned.

Stated Meeting, March 3, 1876.

Present, 10 members.

Mr. Eli K. Price in the Chair.

Letters of acknowledgment were received from Dr. Jacob Bigelow (95); Silliman's Journal (95); the Smithsonian Institution (95); the Emden Society (92); and the Physical Society in Berlin (87 to 91; xiv, 3, xi, 1).

Letters of envoy was received from the Coast Survey; from the Physical Society in Berlin; and from the

Royal Irish Society, requesting missing Parts 2 of Vol. iii, 1

Digitized by Google

of xiii, and 2 of xiv, to complete the set, which was on motion so ordered; also from

The K. Leop. Car. Deutsch Akademie der Naturforscher requesting exchanges, having only Trans. Vol. I. O. S. 1769. The request was referred to the Publication Committee with power to act; also from

A. J. Holman & Co., 930 Arch street, tendering a request for the loan of the Elliot Bible in the Library of the Society. The request was referred to the Library Committee with power to act.

The request of the Philadelphia College of Pharmacy for No. 93 to complete their set, was granted.

Donations for the Library were received from the Geological Institute at Vienna; the Leop. Car. German Academy at Dresden; the Prussian Academy, and Horticultural Society, and Herr Schwalbe of Berlin; the Society at Emden; the Belgian Academy; the Geographical Society and Reviews in Paris; the R. Astronomical and Geographical Societies in London; the Natural History Society at New Castle; the R. Irish Academy; the Boston Society N. H; the Cambridge Museum C. Z.; Silliman's Journal; American Chemist; Dr. J. S. Newberry; Poughkeepsie Society of Natural Sciences (ordered to be placed on the list to receive the Proceedings); Journal of Pharmacy; Penn Monthly; U. S. Department of the Interior; U. S. Coast Survey; Georgia Historical Society, and the San Francisco Mercantile Library Association.

Mr. Wootten communicated, through Dr. Cresson, a paper on the successful use of anthracite coal-dirt on a new form of locomotive, drawing coal trains, on the Reading Railway, and described on the blackboard the form of fire-box floor, draft tuyeres, absence of exhaust and smoke stack, length of flame, &c., &c.

Pending nominations Nos. 792, 793 were read, and the meeting was adjourned.

Digitized by Google

A Combination of Apparatus by which ordinary Anthracite Coal-waste, from the Dirt-banks at the Mines, can be successfully and profitably burned in the Furnaces of Stationary and Locomotive Boilers.

By John E. Wootten, Reading, Pa.

(Read before the American Philosophical Society, March 3, 1876.)

Prominent and peculiar features in the landscape of the Coal Mining Regions are the enormous heaps of black and apparently useless material collected near the outlet of each mine. The nature of this material can be best understood by a brief consideration of the source from which it comes.

The coal measures are made up of veins of coal of varying thicknesses and constitution. The coal of which they are composed, especially in the thicker veins, has mixed with it layers of slate, sometimes in mass, at other times finely laminated and disseminated throughout the seam.

As the coal is found in beds interstratified with rocky formation, it is subject to similar accidents as are the rocks themselves when disturbed by convulsions of nature ; therefore when portions of a vein are crushed and rendered unfit for use as marketable fuel, it must, notwithstanding its unfitness, be removed from the mine to permit access to the more valuable coal.

Seams of considerable thickness are usually divided into separate beds of varying thickness, by deposits of slate, which impurity must be removed in the preparation of the coal for the market ; and the same seam may furnish several qualities of coal.

The great heaps of material to which we have referred, are thus the results of the various operations of mining and preparation of the coal for market. They contain therefore, in addition to the earthy matter, slate and rock already mentioned, a large portion of the purest coal taken from the colliery, not only that which is crumbled into small fragments during the operation of mining, but also that, which having passed through the breaking rollers is crushed into particles of too small size to be merchantable, and is for that reason consigned to the dirt heap. The last named contribution to the heap constitutes from twelve to fifteen per cent. of all the good coal that is mined, and is the result of the wasteful method which is employed to reduce the large lumps to the uniform sizes required by the demands of the trade.

Some of these heaps are the accumulations of half a century, and have been exposed during their formation to the action of the weather and such atmospheric influences as have lessened their value for heating purposes by loss of carbon and saturation with moisture.

We have therefore, in dealing with these masses as fuel, to overcome the difficulties consequent upon their containing a very large amount of incombustible matter, all of the elements for the ready production of clinker and incapability for producing an active or vigorous fire in the ordinary furnace.

To consume this material with useful effect, it is necessary either to sub-

Digitized by Google

ject it to a process that shall form it into masses of moderate dimensions, so that when thrown into a furnace, interstices may be left to allow of access of air to the surface of the lumps. in the same manner as is the case with ordinary lump coal; or else special means must be provided to retain and consume it in the furnace; and peculiar appliances be made use of to insure the passage of air through the fire-bed and its proper contact with the fuel. In either case provision must be made as far as possible for the prevention of the formation of large masses of clinker and the disposal of the ash.

The first method referred to, that of forming the coal waste into lumps of proper dimensions, by the admixture of clay or bituminous matter, or other cohesive material, can only be profitably employed when the cost of the operation is less than that of mining and preparing coal at the colliery.

Heretofore the largest proportion of the coal mined was from above the water level, and the comparatively low rate at which such coal was mined prevented the successful application of any processes for agglomeration.

As the coal above the water level is being exhausted and deep mining has become necessary, the increased cost has directed attention to the utilization of the waste coal under consideration.

A large investment of capital in machinery may bring the cost of manipulation below that of mining; but it is not likely that the run of the waste coal heap can be utilized by any such process, as it contains so large a proportion of foreign and incombustible material.

It is obvious that if the coal in its minutely sub-divided state can be advantageously consumed by means of any process or device which shall be moderately simple in its construction and no more expensive of maintenance, than an ordinary boiler furnace, the problem of utilization of coal waste will have been solved, and a very considerable economy in cost of fuel attained.

With this object in view, a method of consuming the material in question has been devised and may be described as follows:

Air is injected into a closed ash-pan by means of a steam jet passing through one or more tubes. These tubes should be cylindrical, when volume of air without much intensity is sufficient; but when greater intensity is desired, as in the furnace of a locomotive, they should each be formed of two frustrums of cones, united at their smaller diameters; the proportions of the larger and smaller diameters varying with the degree of intensity of blast required.

The mingled air and vapor pass through a perforated fire-bed into the fuel in the furnace, and are thus evenly distributed through the fire, the fuel being spread over the fire-bed to a depth of about three inches.

The fuel upon the grate is gently lifted by the blast from over the perforations, the finer particles floating upon the current until the carbon is consumed; a large proportion of the ash passing off in a finely divided state, with the draft out of the stack.

The decomposition of the vapor in passing through the fire, results in

Digitized by Google

the production of hydrogen and hydrocarbon gases, in addition to the carbonic oxide usually formed.

The blue flame of carbonic oxide is to a great extent replaced by that of the hydrocarbons and hydrogen. The combustion of this fuel resembling that of bituminous rather than anthracite coal; the flame extending occasionally to a distance of over twenty feet, instead of as many inches, as is the case in the combustion of carbonic oxide gas from ordinary anthracite coal burned in the usual manner.

The decomposition of the vapor causes a considerable reduction of temperature in the furnace. This cooling effect in the furnace does not, however, result in a loss of heat, as the re-combustion of the hydrogen derived from the decomposition of the vapor yields as much heat as was absorbed in its formation.

To insure the rapid and complete combustion of the fuel, and prevent the formation of solid masses of clinker, it should be repeatedly stirred upon the fire-bed with a rabble-shaped tool. This stirring process is an important element in the successful use of the fuel under consideration, as it serves to relieve the fire from the finely divided ash, which is thus exposed to and carried by the draught over the bridge-wall or through the flues of the boiler into the stack.

The perforated fire-bed forms an essential feature of the device, inasmuch as the loss of fuel through the grate during the stirring process is thereby greatly diminished, the average loss being less than two per cent. of the coal put into the furnace, whilst the weight of the fuel used for steam generation and stationary and locomotive boilers, is but slightly in excess of that which would be required of standard marketable sizes of prepared coal when burned in the same furnace with the ordinary bar grate in the usual manner.

The perforations in the plate of the fire-bed, are made from three-eighths to three-fourths of an inch in diameter, and from two to three inches from centre to centre.

Wrought iron is preferred for making the perforated fire-beds, as that material admits of the use of a much thinner plate than cast iron, and consequently there is less liability to obstruction of the air passages.

The exhaust blast of the locomotive is altogether unsuited to the consumption of the fuel under consideration, as by reason of its impulsive and vigorous lifting action, it is impossible to maintain the fire in the comparatively quiescent condition requisite for favorable results with anthracite coal dirt.

The usual method of urging the fire by means of the exhaust steam has therefore been entirely dispensed with, and instead of discharging the exhaust steam directly into the atmosphere, its heat is absorbed as far as possible, by passing it through tubular feed water heaters before allowing it to escape.

By this means, feed water is introduced to the boiler at a temperature in excess of 212° F.

Digitized by Google

A locomotive engine, using coal dirt exclusively for fuel, has recently been engaged in hauling coal trains over the Philadelphia and Reading Railroad, generating steam freely without the use of any portion of the exhaust steam as a draught-promoting agent, the substitute being a continuous supply of air and vapor, introduced into a closed ash-pan as above described, aided by very small jets of live steam in the chimney for the purpose of facilitating the passage upwards of the products of combustion.

These results obtained from many boilers now using the apparatus described, show that the hitherto neglected and apparently valueless material, known as coal dirt, can be profitably used for generating steam, and that hereafter it must be regarded as a fuel of great value.

Stated Meeting, March 17, 1876.

Present 16 members.

Dr. Bridges in the Chair.

A letter acknowledging the receipt of Trans. V. and Proc. 94, was received from the Boston Society of Natural History.

Donations for the Library were received from the Bureau of Mines at Victoria, the Society of Physical Science at Bordeaux, the Revue Politique, Canadian Naturalist, Boston S. N. H., American Antiquarian Society, Bedford Library, Astor Library, Franklin Institute, Medical News, Prison Discipline Association, Geological Survey of Pennsylvania, Geological Survey of Ohio, and President Allen.

Prof. Houston communicated again his views respecting the so-called new force, and in reference to certain strictures which have appeared in print, since his former communication. He described the results of experiments proving a polar condition of the force, and demonstrating the impossibility of its being anything but electricity under stratical tension.

Mr. Eli K. Price continued the communication of his views on the Glacial Epoch, so-called, arguing against a general polar outspread of ice, and for the explanation of all drift phenomena on the theory of iceberg distribution.

Digitized by Google

Prof. Chase exhibited diagrams representing certain mathematical and astronomical relationships of length, orbital movement and planetary distance, which he stated and described, including in his subject matter of discussion the possible influence of the meteor-belts.

Pending nominations Nos. 792, 793, and new nominations Nos. 794 to 802 were read.

On motion, the Committee appointed at a previous meeting to consider the expediency of an exhibition of the Progress of Science in the last hundred years, was discharged from further consideration of the subject.

A request by letter from Mr. Etting that the Society permit the exhibition of its original draft of the Declaration of Independence by the city in the Museum of the City Hall, was, on motion, referred to the Curators to report.

And the meeting was adjourned.

ON SOME DISPUTED POINTS IN PHYSIOLOGICAL OPTICS.

BY HENRY HARTSHORNE.

(*Read before the American Philosophical Society, April* 21, 1876.)

I. ON THE THEORY OF ERECT VISION, WITH INVERTED RETINAL IMAGES.

As it has been ascertained, by both mathematical and physical demonstration, that the image of every object seen must be inverted upon each retina, several explanations have been offered for the correspondence of our sight with the actual position of visible things. The most prominent views advanced are the following :—1. That we do see everything inverted, but that the correction has been obtained, and has become habitual and momentary, through *experience;* 2, that the reversal of all images is effected by the crossing of the filaments of the *optic nerves;* so that, e. g., all the filaments from the upper part of the retina go to the lower part of the optic ganglia at the base of the brain, and *vice-versa;* 3, that we do not mentally regard the image or picture *upon the retina* at all, but look *from* the retina, *at the object;* or, as one authority upon the subject prefers to express it, "the local change excited in the retina must be conveyed to the optic nerve, communicated to the brain, and again, in an inverted direction, projected outward; through this double inversion the projected image corresponds to

the object, and we therefore say we see the object when only the projected retinal image is before our eyes."

Against the hypothesis of the correction of inverse vision by *experience*, we have, first, the clear and, so to speak, imperative testimony of every one's consciousness; secondly, the very satisfactory observations and experiments of Spalding and others, upon newly hatched chickens and new-born pigs. The chicken just out of its shell, or one, after hatching, hooded for a day or two and then allowed to see, will *at once* locate an object brought near it (as an edible seed or grain), seizing it accurately with its bill; and will, also, *at once* run in answer to the cluck of the hen, almost always in a *direct line*. Similar facts, precisely, have been observed with pigs immediately after their birth. Thus, *in these animals*, the non-necessity of experience, even for the visual measurement of distances at short range, is proved; much more then must it be impossible that experience should be needed to set things upright, they being inverted according to actual vision. While analogy here only affords a probability as to what is true with regard to human sight, that probability is nevertheless very strong indeed: not that correct visual impressions in all respects are *congenital* with man, as our observation of infants does not seem to show; but that at least the simpler elements of vision attend in their development the maturity of the eye as an organ; and that among these elements, the sight of objects as not inverted must be one of the simplest. If it be said that the readiness for use of the senses and faculties of some new-born animals is a result of hereditary transmission, *a race-experience*, accumulated through long periods of time, I have nothing to say against this as, in itself, a not improbable hypothesis, in regard to the mode of *origin* of such endowments. But the idea of experience which is involved in the view just above-mentioned, is quite different from this last. Experimentally acquired corrections of positive sensory perceptions never go so far as to *annul* the perception which has to be corrected, to such an extent that the *process* of correction *cannot be ascertained by consciousness*.

On the hypothesis that the inversion of the retinal images is effected by a uniform decussation of the optic nerve-filaments, it is needful to remark only three things: 1, that this must be a pure assumption, no such mode or plan of arrangement of the filaments of the optic nerves being anatomically discoverable; indeed, a much more general and intricate plan of exchange of filaments, between eye and eye, optic ganglion and its fellow, and all the parts of the two eyes and the two ganglia, having been proved to exist; 2, that such an explanation is opposed to all the analogies of nerve-distribution, in regard to the localization of impressions; the relative *position* of the nerve-*trunk* or its filaments, never affecting much if at all, our perception of the locality of any sensation; all notions of locality or direction, under normal circumstances, being obtained by means of, and *at* the *organ*, not the transmitting or communicating nerve, of sense which is concerned; 3, that the same reversal of position of the image or picture on the retina produced by rays from an object seen, must occur *horizontally* as well

Digitized by Google

as vertically, the rays from the right side of the object crossing those from the left side as they enter the eye, so that (as in a mirror) what is right side in the object is left side in the retinal picture, and conversely; the difficulty of the anatomical explanation referred to being at least doubled by this *complication* of reversal.

It remains here for me to assert my adherence to the opinion, which is generally growing in favor with physiologists, that much the nearest approach to a solution of the problem of upright vision with inverted retinal images must be expressed in terms essentially conforming to the 3d of the hypotheses above briefly stated. The phraseology used in the passage which I before quoted, making "an image projected outward" that which (not the object) is seen, does not appear to me to be necessary, although it has convenience in describing the analysis of some of the phenomena of vision.

That which it is especially my design to remark upon in this connection is, the clear illustration furnished by our visual experience, and sustained by that of our other senses, of the *externality* belonging to, and inherent in, all sense-perceptions. *Direction* of sound is apprehended, even with only one ear open to receive it; the precise *rationale* of our recognition of the direction of sounds not yet being agreed upon amongst physiologists. I believe that it is obtained by the exquisite sensibility of the orifice, and parts near it, of the external meatus of the ear; a sensibility intermediate between auditory and tactile sense; a kind of gradation existing here, which, there is reason to think, has many illustrations in the partially dfferentiated sense-organs of lower animals. So, also, we judge, in case of touch, of the *direction* from which anything comes, a ball, for instance, striking the hand, by reversing, as it were, the central axis of predominance of the impressions made; which is analogous to the ocular visual axes, whose correspondence gives us single object-perception in sight.

II. On Extuition as a New Term in Psychology.

My reason for dwelling at some length upon the above points of statement is, that I conceive it to be of consequence in psychology (which in regard to sense-perception, especially, is inseparable from physiology), that a more distinct apprehension should exist than has hitherto prevailed, as to the essential, original and inherent, *externality* of the report made to our consciousness by *all* our organs of sense, of the impressions made upon them. In the but partially inductive study of psychology of past times, to which the term "metaphysics" may be, without disrespect, applied, the idea of the Cartesian formula, "Cogito, ergo sum," has been accepted in too exclusive or monopolizing a manner. This was, and is, a deduction occurring in the self-consciousness of the mature philosopher. Could a child, a year old, give its mental experience, so as to define its way of arriving at the knowledge of the *ego*, of its own personal existence and identity, it would doubtless say, "*Percipio, ergo sum.*"

Not uncommonly, authors on psychology assert, in effect, and sometimes

Digitized by Google

in their very words, that sensation is in the first place always *intuitive;* the process of perception then following, by which a reference of the quasi-subjective impression of consciousness is made, to an external cause. Now I believe that we are justified in denying the correctness of such language; and refusing to admit that sensation is *per se* intuitive, in any proper sense of that word. *Subjective* it may be, just in so far as it is an affection of the subject whose organs of sense (and through them the consciousness) are impressed. But I would insist that the affection of consciousness in sense-perception, nay, in primary *sensation,* is distinctly *objective* in its nature; at least to the extent that the bodily organ affected (not the central *ego* of the metaphysician, nor the brain which receives the terminations of the nerves of sense) is always, to us, the *immediate seat* of sensory cognition; while, at least in the cases of sight and hearing, *externality* belongs, by the law of our constitution, to sense-perception, in its primary nature; not needing a secondary process to attach the inference of outwardness to it. We cannot explain this farther than to say that it is the fact or law of sense-cognition, according to our bodily and mental constitution; but this is true of any and every other view of the subject which may be taken, whether old or new; and the legitimate aim of psychological science must be, as with any other science, to find by observation, experiment and careful induction, *what are* the facts and laws of mind, in all its actual relations. I believe that it may promote definiteness of thought upon this subject, to introduce a new term into psychology; namely, *extuition.* While the word intuition is, as familiarly used, well adapted to denote the reflective process, by which *ideas of reason* are obtained, it appears to be altogether misapplied when the same word is made (as by some leading authors it is) to indicate also the mental affection or act occurring in *sensation.* The importance, in my judgment, of this addition to the language of philosophy, of so explicit a term as extuition, conveying a meaning for which there is now actually no existing word, and scarcely a simple English phrase, is the *raison d'être* of the present communication. Word-making has always against it a strong presumption of uselessness, if not of impropriety; but in this case, the presumption seems to me to be over-ruled by a real necessity of thought and of expression. By means of the thought which is intended to be thus expressed, a satisfactory antithesis, and (as it is *inductive*) a tenable refutation, of Berkleyan idealism may be obtained; through the aid (too often overlooked by psychologists) of some of the most clearly demonstrable facts of physiology. Our sensorial consciousness affirms the reality and externality of the objective world, no less *simply, directly* and *positively,* than our reflective consciousness affirms our subjective being.

III. On Ocular Color-Spectra and their Causation.

In order to introduce a few observations which, if not novel, have at all events been but seldom noticed, and to bring forward what I believe to be a new explanation of a remarkable group of optical phenomena, it is need-

Digitized by Google

ful to refer to some facts familiar to most of those who have given attention to physiological optics.

When the eyes have been directed for a short time to a *bright* object, as a piece of polished silver, and they are then turned towards a white wall or other light surface, a *dark* spot or figure, having the outline of the bright object first seen, is beheld upon the white or light surface. Or if, on the contrary, a *dark* body, as an inkstand, for instance, be looked upon steadily for awhile, on turning the eyes toward a light ground, a brilliant *white* corresponding figure is seen. These are called *negative spectra*. If, now, instead, we look fixedly at a *colored* object, and afterwards turn the eyes to a white ground, or, if the colored body be *upon a white surface* and, after a time, this body be *removed*, we we will see, in either case, a spectrum having the *color complementary* to that of the object beheld. These are, also, commonly called negative spectra; the expression *complementary color-spectra* will designate them more accurately, without regard to theory.

It has been noticed that, near sunset, the rays of the sun passing through an orange-colored cloud cast bluish shadows; and likewise, the shadows of of objects seen behind red curtains are apt to be green. If the light either of the sun or of a strong artificial light be made to pass through a pane of colored glass, so as to fall upon a white ground, and a slender object, as a rod, or the hand, intercepts the colored light, the shadow thrown has the *complementary* color to that of the transmitting pane. Red glass will thus throw green shadows, green glass red, orange glass blue, &c. If we look at the shadow, so thrown, through a tube, so that it alone is seen, it is perceived as a shadow without color. Also, if the same shadow falls upon a *black* surface, no shadow appears.

The above mentioned facts have all been repeatedly observed; and but one explanation, so far as I can ascertain, has, as yet, been proposed for them.* It is that suggested by Dr. Thomas Young, and accepted by Helmholtz. Young's theory of colors, being the application to vision of Johannes Müller's general theory of special sensation (as depending upon the character of the sensory *organ* more than on that of the external cause), asserted the existence of different susceptibilities to color rays in different portions of the retina; or among the different optic nerve-filaments. With our present knowledge of the minute structure and relative functions of these parts, such special susceptibilities, viz: to red, green and violet light, as Young designated the primary colors, or to red, yellow and blue, as they are more commonly named, may be referred to the posterior layer of the retina; the layer of *rods and cones* of Jacob and Max Schultze. Helmholtz adopts this theory of Young, as the only one giving any clue at all toward solving the

*Since this was written, I have read, in Lardner's treatise on Optics, a brief statement of Plateau's theory, of an "oscillatory movement" of the whole retina, when affected with light, in connection with what he designates as a resistance of the retina to the action of any color, and a tendency to resume its ordinary condition, with a more or less intense force. There seems to be extremely little evidence in favor of this theory; and it has apparently fallen out of view in later works.

Digitized by Google

problem of the vision of colors; which, as the great German physicist declares, had baffled not only the powerful mind of the poet-philosopher Gœthe, but many able students of physics and physiology besides.

There seems to be no good reason for hesitating to accept this theory, of the special responsiveness of certain retinal nerve-elements to particular luminous rays. Helmholtz supports it by at least one striking fact in the comparative histology of the eye; viz: that in a number of birds and reptiles, many of the rods of the retina contain, at their ends which are turned towards the light, minute drops of colored oil; in some red, in others yellow; while others of the rods in the same eyes are entirely colorless. Also, he refers to the analogy of the *organs of Corti* in the cochlea of the ear; which are supposed, with considerable reason, to vibrate in accordance with particular notes of sound; and, also, to some remarkable external filamentous appendages to the organ of hearing in certain marine crustaceans; which Hensen, of Kiel, has shown to be set in motion, some by one, and some by other kinds of sonorous vibration. These last facts recall the admirable and similar series of experiments of Prof. Mayer, upon the vibrations of the antennæ of mosquitoes. I believe that there is much importance in this general theory of undulatory consonance, and of special responsiveness, of the minute elements of the organs of sense. It is in the *manner* of the *application* of this theory by Helmholtz, and, with him, by all other late physiological writers known to me, to the explanation of *negative* and *complementary color spectra*, and *color shadows*, that it appears to me a deficiency exists, fatal to the reception of that current explanation; and suggesting, if not proving, an almost or quite contrary view of the same facts.

The application I here mean to object to, is this: that negative and complementary color spectra and color shadows are all explained by partial or local *fatigue* of the retina, under impressions of light, so that the part of the retina impressed, e. g., by a particular color, becomes, through fatigue, less sensitive to the same color, kind, or degree of light; and therefore an impression is, during the time of that fatigue, made upon our visual consciousness only by the opposite or complementary rays; these affecting those parts or elements of the retina which are fresh, not having been wearied by use. According to this, when we look for a time upon a red object, those rods and cones, or nerve-cells, or nerve-filaments (or, as Prof. Draper would have it, portions of the *choroid coat behind* the retina) which are affected by red rays, become exhausted; and so, when we turn toward a white ground, we are, for the time, red-blind; while the *green-seeing* capacity, so to speak, is fresh and vigorous. Thus we see, at that time, only green; or, the complementary color in any other like case. This *fatigue* theory is what I am constrained, notwithstanding the very eminent authorities by whom it has been hitherto supported, to call definitely in question. Let me here mention the observations which first led me to look for a different view of the whole subject of these kindred phenomena.

If a piece of thin white paper, such as is commonly used, on account of

Digitized by Google

its light weight, for foreign correspondence, be laid over a piece of brightly colored material (paper, silk, flannel, or any other) and then on the latter a small black or dull colored strip or fragment of any kind be laid, under the paper, this *fragment or strip* will appear to be of the color *complementary* to that of the *larger and brighter ground* upon which it is placed. Any color will answer for this experiment; although the effects are most distinct with red and green grounds; tolerably so with bright yellow; least so with blue, purple, and all dark shades. It makes no difference what is the *hue* of the *fragment* or *strip* upon the brighter ground under the paper, so long as it is duller or darker, as well as considerably smaller, than the ground on which it is laid; it will always have the color complementary to that ground. Put, for example, together, under the thin paper, on a bright green ground, strips of blue, red and yellow glass, and one also of black worsted or paper; all of these, seen through the paper, will be, *alike*, distinctly *red*.

Now, on observing these facts, let it be noticed, especially, that the effect produced, the complementary color given, is *instantaneous*. The moment you look at the bright ground with the dull or indifferent strip over it, you *at once* see that strip with the *complementary* color. Lift the paper, and the real hue, or blackness, is seen; replace it, and it becomes again changed as before. There is here *no time for fatigue* of the retina, or of any part of it. Again, if the bright ground have, around it, a *margin* of the paper which is laid over it, that margin will have a faint but distinct *flush* of the complementary color. If the bright ground be *moved* to and fro, this overflush of color may be, sometimes beautifully, shown, following the line or edge of the moving mass of strong color; and most distinct near the edge. This effect, also, is instantaneous; there is no opportunity for *fatigue* in any way to explain it.

Finding then, this "fatigue" theory quite insufficient for these facts, attention to the phenomena of *color-shadows* above referred to, has impressed me with a belief that the same theory falls short with them also. They are, likewise, immediate, momentary effects. You look at the white ground, bathed in colored light, which light is partly intercepted by a narrow opaque object; and *at once* you see the shadow of the latter, having the complementary color; there is no possible time for fatigue, or for loss of any portion of the retinal sensibility.

Consideration may next be in place, upon a remark of Helmholtz,* which, though only parenthetically made by him, has very considerable importance. Bright objects, as flames, or the sun, when looked at, give subsequent spectral effects unlike those described as negative. They are, indeed, for a time at least, *positive* spectra. Helmholtz speaks, moreover, of from *half a minute to five minutes'* contemplation of a bright or colored object to produce the *ordinary* negative or complementary color spectrum by looking upon a white ground. I have found from *five to ten seconds* ample, with a kerosene students' lamp; and less time still, with strong sunlight.

*Popular Lectures, transl., 1873.

Digitized by Google

My experiments with sun-spectra, designed for the purpose of examining more particularly the above facts parenthetically mentioned by Helmholtz, were as follows: At about three o'clock on the afternoon of a clear day I held between my eyes and the sun, a pane of colored glass; using, at intervals, successively, four colors; blue, green, red and orange. After a few seconds, I turned my eyes from the glass upon a white-washed wall. In each case, a strong complementary (so-called negative) color spectrum was seen upon the wall; but, on *closing* my eyes, an almost equally intense *positive* spectrum, having, that is, the *same* color as the stained glass just looked through, appeared. Opening my eyes, the *complementary* spectrum returned; again closing them, the *positive* one; and so on, for half a dozen or a dozen times in succession. A member of my family, and, on another occasion, Prof. E. J. Houston, repeated this observation, with the same results; and I also did so, with entire success, with a magnesium light, at night. These experiments seem to me quite fatal to the supposition that retinal fatigue can account for any class of spectra such as have been above considered; for, if ordinary luminous impressions produce temporary fatigue and loss of sensibility, *stronger* impressions ought to produce still *greater* fatigue and greater loss of sensibility, or partial color-blindness, from that cause; whereas the reverse is the fact. As Helmholtz states, and as Newton found in his famous experiment, which proved dangerous to his sight, very bright objects, such as the sun itself, give *positive* spectra. In Newton's case, after gazing directly at the sun, its image did not pass away from his vision, whichever way he looked, for two or three days. Looking through colored glass, my daughter obtained a solar spectrum which continued for nearly twenty-four hours. In my experiments just mentioned, if it were possible for fatigue to account for the *negative* or complementary spectrum seen with open eyes, what conceivable relation (I certainly think none) can such a cause have, to the *positive* spectrum seen when the eyes were *closed?* If fatigue might *take away*, so to speak, the capacity to see green light when the eyes were *open*, it is against every "law of parsimony" in science to suppose that the same cause could *confer* the capacity to see a green image or spectrum, when the eyes were *shut*.

Another experiment, decisive against the fatigue theory, is one by which a *derived* or *secondary* spectrum may be obtained, as follows: a small square or circle of white paper or muslin is placed in the middle of a large brightly colored ground, red, for instance; and is steadily looked at for from a quarter to half a minute. The white central spot will acquire a tint of the complementary color (green, upon red), increasing in depth with prolonged attention, and especially strong at the nearest point of distinct vision. Then let the eyes be turned to a white ground; there will appear upon it the usual complementary (in the case supposed, green) spectrum, of the ground; but, at the *centre*, there will be also a clear *positive* (red) spectrum, corresponding in place and size, with the *white* central patch. Here, of course, that part of the retina which had received *only white* light, could not, on the fatigue hypothesis, be supposed to lose its sensibility to green,

Digitized by Google

through exhaustion from special use; while, on the theory which I am about to set forth, the mode of causation of the secondary as well as of the primary spectrum appears quite clear.

It remains, then, to attempt a definite answer to the question, what explanation, conforming with all these facts, can be substituted for that which I have ventured to pronounce unsatisfactory. I make an endeavor in this direction with diffidence; not possessing so precise an acquaintance with physics as might enable me to deal as an expert with so difficult a subject.

Allusion has been made above to four kinds of phenomena; which may be thus briefly named *en résumé:*

a. Those of ordinary *color spectra,* primary and secondary, seen with moderate light.

b. Color shadows thrown under transmitted light.

c. Over-tints and *complementary shades,* seen through thin paper, on a brightly colored ground.

d. Solar color spectra, positive and complementary by turns, according to whether the eyes are closed, or opened towards a white ground.

These all appear to me to have a common character, and to require an essentially identical explanation.

Take, first, the ordinary color spectra, such as may be obtained with good lamplight. Looking at a red object for a few moments, one then turns the eyes to a white surface; a green spectrum is seen. Why is this? Because, to use the simplest and least hypothetical phraseology, the eyes are *charged, saturated* with red light; and this, having a certain strength, is *neutralized* by the red rays in light reflected from the *white* surface, so that only the *remaining,* complementary, green rays of that light affect the sight. Translating these expressions into language in accordance with the undulatory theory, I would say that, when a brightly colored object is looked at, those rods and cones, or minute retinal nerve-elements, which respond in vibration to the luminous ether-waves of the color reflected to the eyes, are excited to motion thereby; and by "irradiation," or communication of vibrations, all retinal elements which have *the same period of vibration* are made to partake, in some degree, of this movement. Then when, turning from the colored object, *white* light, consisting of all the color-rays or waves together, impinges upon the eyes, those ether-waves of the white light which belong to the color first acting on the retinal nerve-elements, *interfere with,* and for the time relatively diminish or *annul* the special vibrations already produced in the retina; leaving the *other* waves of white light to take effect upon the retinal elements which respond to or "resonate" with them, so that the *complementary* color only is seen.

Very probably *relative diminution,* rather than total arrest, of the special retinal vibrations, is what occurs. All our perceptions of light and color are, to a considerable extent, dependent on the *relative intensity* of light from different sources or of different kinds. When, then, in a beam of white light, a *portion* of certain color rays is, in effect, arrested by previously existing retinal vibrations of the same period, although the *remaining* rays

Digitized by Google

of the same color might affect the sight *if they were alone*, they are, as it were, overpowered by the unimpeded complementary color-rays. This consideration appears to me to meet an objection to my "interference" theory, suggested by Prof. Houston; derived from the necessary relation of *wave-length* of rays for interference. If only a moiety of the ether-waves of a certain color in a beam of light afford the required opposition of phase in undulation, their arrest or subtraction may yet explain the *relative* lessening of the intensity of that color, so as to cause it to cease to be perceived; the complementary color-rays having twice as great a strength.

When color shadows are produced by intercepting transmitted colored light, the shadows must fall *on a white ground*, or they do not have the color complementary to that which is transmitted. Here, again, the eyes becoming saturated with a certain color, *its* specially responsive nerve-elements in each retina are set in vibration; and, as in the other case, interference occurs between these vibrations and the ether-undulations corresponding with the same color, in the reflected (diffused) white light Let the shadow of the intercepting object fall upon a *black* surface, and the complementary color disappears. Nor will it be seen when only *monochromatic* light is present in the apartment.

Again, the above-described *over-tints* or flushes, and complementary interrupting spots, strips or bands, upon a colored ground seen through thin white paper, depend upon the *white light reflected* by that paper, for their complementary color. If the paper be removed, the actual difference between the ground and the spots, strips or bands laid upon it, will be clearly seen. Replace it, and *at once* a strong contrast re-appears; as before, I hold, resulting from the interference of equivalent vibrations.

Lastly, when a very strong impression is made upon the eyes, as by looking at the sun through a colored glass, the excitement of the nerve-elements is so great as to *persist* in the same manner; producing continued sensation of the same color, when the eyes are closed, for some time. But, when the eyes, in this state, are opened upon a white ground, again the waves of the *same* color-rays in the white light *kill*, as it were, that color in the eyes; or, in other words, arrest, for the time, enough of the existing retinal vibrations to annul their effect in sensation, so that only the remaining (complementary) rays of light are perceived. Bright reflected white light thrown even upon the *closed* eyes will have this effect.

An analogous explanation will suffice for the *secondary* or *derived* spectra, mentioned on a previous page. Looking steadily at a small white spot on a red ground, for example, the white spot becomes green; turning thence to a white ground, a large green spectrum is seen, with a red spot in the centre. The latter I call a secondary spectrum. While looking at the *red ground*, vibration of the *red-resonating* retinal nerve-elements began, and was extended, by irradiation, to those covering, in vision, the *white spot* in the centre; being, there, sufficient to *neutralize* the *red* rays of the white, and thus allowing only green to be seen, by vibrations of the *green-resonating* rods and cones of *that part* of the retina.

Digitized by Google

On turning then to a *white ground*, most of the retina being *charged with red* by the previously contemplated red ground, the usual *complementary, green*, spectrum of that ground is seen; but at the *central* part of the retina, whose *green-resonating* elements have been set in vibration (as above said), *their* vibrations are annulled by the *green rays* of the white ground; leaving only the red rays of that ground to take effect, and producing a (secondary) red spectral spot upon the green.

These facts are, it appears to me, all closely similar in nature to the commonly observed interference occurring between diffused sunlight and lamp or candle flame; and, also, they have a definite relation to the mode of production of the Fraunhofer dark lines or "absorption bands" of the spectroscope; while they suggest some further speculations in regard to what may be the molecular conditions of reflecting surfaces which give to our vision impressions of different colors, to enter upon which, at present, would extend this communication to too great a length. I may simply add that, on careful examination of ocular spectra obtained by looking at colored objects by lamplight, as well as by sunlight, I have become convinced that the influence of light entering through the *closed lids*, if they are uncovered and within range of a luminous source, such, even, as that of a student's lamp, is not at all indifferent. A spectrum, obtained as usual, seen with closed eyes, and fading away while they are covered, may be *renewed* by approximating the eyes, *still closed*, to the light; and this again and again, several times. In order to test yet farther the sensitiveness of the eye, when closed, to light, I placed several pairs of glass slips, of different colors (blue, red, green and orange), in the hands of an assistant; laying them, then, as given to me, in turn, upon my closed lids, while my eyes were turned towards the afternoon sun. In every case, I could discern clearly the color of the glass; but only in the direct rays of the sun; diffused daylight, and lamplight failed, with me, to give more than a doubtful discrimination of color, even with near contact of bright translucent objects, while the eyes were closed.

Incidentally, I may mention also, my careful repetition of a very curious experiment mentioned by Sir. David Brewster in his Optics, and brought to my notice by Prof. E. J. Houston. A strip of white paper is held vertically, about a foot from the eyes; the attention is then fixed upon an object at a greater distance, so that the slip of paper is seen double; and at the same time a lighted candle is brought near to the side of one eye, so that its light will affect that eye strongly. The image of the strip seen by that eye (if the *right eye* be illuminated, the *left-hand image*, and *vice versa*) will be *green*, and the other *pale red*, I find that, when these two images have been obtained, one eye can be closed, but the same color still remains. Brewster asserts that when *two* equal candle-lights are used, one being held near each eye, two *white* images will be obtained. With me, this does not prove to be the case. I see, with two candles, *two green* images instead; and, fixing the eyes on the strip for *single vision*, with two candles placed as before, it is seen of a *distinct green* color. Without insisting upon it, I would pro-

Digitized by Google

pose as a hypothetical explanation of these results, the throwing of *red light* upon the retina by the light of the candle passing *through the blood vessels* of the eye-ball; this red light, in the eye most illuminated, *killing* the red-light vibrations of the retinal elements, so that only green is seen. The pale red of the image seen by the *unilluminated* eye is, with me, of doubtful distinctness.

If the facts and arguments which I have set forth in this paper impress other minds as they have done my own, especially in view of the *instantaneousness* of many of the phenomena described, and on which I have wished to lay particular emphasis, it may, at least, be concluded, that the commonly accepted theory, proposing to account for negative and complementary spectra by partial *fatigue* and diminished *sensibility* in the retina, will not suffice; and ought to be abandoned, as not at all reconcilable with several clearly demonstrable facts. Should my above attempted explanation, by *interference* (or *saturation* of the retina with certain luminous rays, and *neutralization* of a portion of the same by equivalent rays present in reflected white light), not prove altogether satisfactory, it may be an interesting task, not without importance in physiological science, for some one well-versed in the physics of the subject to give it such farther attention as may solve the problem, in a manner which meets, as has certainly not hitherto been done, all of its conditions. I ask leave to verify some of my assertions as to the facts referred to in this paper, by repeating here a few of what appear to me the most decisive of the experiments which have been mentioned.

Stated Meeting, April 7, 1876.

Present, 19 members.

DR. LECONTE, in the Chair.

Letters of acknowledgment were received from the Batavian Society at Rotterdam (XV ii, 94); the Royal Observatory at Bruxelles (XV ii, 94); the Royal Astronomical Society (XIV); the Society of Antiquaries (95), and the Victoria Institute in London (95).

Letters of envoy were received from the Zoologico-Botanical Society at Vienna, March, 1876, and the Meteorological Office at London, dated March 20, 1876.

A letter requesting missing Nos. XIV, ii, 62, 88 was received from the R. Astronomical Society, dated February 16, 1876.

Digitized by Google

A letter was received from Mr. Cleveland Abbe, requesting missing Nos. 93, 94, dated Army Signal Office, Washington, D. C., March 20, 1876.

Donations for the Library were received from the St. Petersburg Botanical Society, Danish Academy, Königsburg Physical Society, the Societies at Ulm and Erlangen, Turin Observatory, Vaudois Society, Bordeaux Geographical Society, Paris Geographical Society, Revue Politique, Nouvelles Météorologiques and Journal des Orientalistes, London Astronomical Society, Meteorological Committee, and Nature, Greenwich Observatory, Boston Academy and Natural History Society, Silliman's Journal, American Chemist, Poughkeepsie Society, Buffalo Scientific Commercial, New Jersey Historical Society, Penn Monthly, Pharmaceutical Association, Medical News, and the Department of the Interior at Washington.

The Committee on Dr. Valentini's memoir reported that they desired further time to compare the photographs with the Mexican calendars in the Poinsett collection of the Society, which was granted.

The death of Theodore Cuyler, on the 5th inst., aged 55, at Philadelphia, was announced by Mr. J. S. Price, and on motion Mr. Henry M. Philips, was appointed to prepare an obituary notice of the deceased.

The death of Hakakian Bey of Cairo, a member of this Society, was reported by the Secretary.

A thesis entitled "Physiological Action of Strychnia, by Dr. Wm. H. Clapp," which had received a prize at the recent commencement of the Medical Department of the University of Pennsylvania, was offered for publication by Dr. Carson through the Secretaries.

A thesis entitled "Sanguinaria Canadensis and its Alkaloids" by Robert Meade Smith, A. B. which had received a prize at the same commencement, was offered for publication by Dr. Francis Gurney Smith through the Secretaries.

These communications were on motion referred to a Com-

Digitized by Google

mittee composed of Dr. Henry Hartshorne, Dr. Bridges, and Dr. Horn.

Mr. E. K. Price concluded the reading of his Discourse on the Glacial Theory.

Prof. Chase communicated, with blackboard illustrations, some astronomical ratios favoring the Nebular Hypothesis.

Dr. H. Hartshorne postponed the reading of his paper "On some disputed Points in Physiological Optics with experiments" to the next meeting.

Gen. Kane made a preliminary communication of his views of the Sub-carboniferous formation and of the structure of McKean County, Pennsylvania, based upon surveys pursued by him through many years.

Pending nominations Nos. 792 to 802 were read.

A report of the Curators was read recommending that the request of Mr. Etting be granted, and on motion, the Librarian was authorized to deliver to Mr. Etting the Original Draft of the Declaration of Independence, owned by this Society, and to take his receipt therefore, and his agreement to preserve the document in a fire-proof safe, except on hours of public exhibition, and protected from the direct rays of the sun, and to return the same on or before the first of January, 1877, according to the terms of his letter of March 23d, 1876.

A report of the Library Committee was read, recommending that the request of Holman & Co., be granted, and on motion the Librarian was authorized to deliver to Mr. Holman the Elliot Bible in the Library of this Society for exhibition in the Centennial Buildings, taking his receipt therefor, and his agreement to return the same in good order on or before the first of December, 1876.

The Treasurer's Report (postponed on account of illness) was read.

The resignation of Mr. Samuel J. Reeves as a member of the Society was read, and on motion accepted.

And the meeting was adjourned.

Digitized by Google

Stated Meeting, April 21, 1876.

Present, 17 members.

Vice-President, Mr. FRALEY, in the Chair.

Letters of acknowledgment were received from the Institute National de France, dated March 31, (XIV iii, and asking for Vol. V i, N. S. and XIV ii), from the Radcliffe Observatory, Oxford, March 30, and from the New York State Library, April 15.

Donations for the Library were received from the Prussian Academy, Annales des Mines, Nouvelles Météorologiques, Revue Politique, Nature, Mus. Comp. Zool. Mass., American Chemist, Cap. Jas. C. Cole, Franklin Institute, Am. Jour. Med. Sciençes, and Mr. A. H. Worthen, of Springfield, Illinois.

Dr. Ruschenberger was, on motion, substituted for Dr. Hartshorne on the Committee to report on the publication of the medical theses presented at the last meeting, at the request of the latter.

Dr. Hartshorne read a paper on complementary spectra, rejecting the commonly received "Fatigue Theory," and offering a new explanation based upon the interference of light rays, illustrating his views by means of colored papers, and the magnesian light.

Prof. Chase communicated certain relationships which he had worked out between the velocity of light and the rotation of Mr. Crooke's new rotation apparatus, and with the phenomena of the "Silenium Eye." To these he added some fresh calculations of the weights of the planets.

Prof. Frazer read a communication which he had received from Mr. Beyton Smith, C. E. of York, Pa., giving a sketch of the literature of the belief in one magnetic pole

Digitized by Google

of declination, and of the counter belief in the existence of two such northern poles; followed by a brief statement of the results of his own field observations and calculations, leading him to the conviction of the existence of two poles, and enabling him to locate their two ellipses of rotation, approximately; not as accurately as he desires to have it done by a more skillful mathematician; but with such an approach to exactness as to be practically useful in his own tests of the age of any given land line. Both poles are located nearly on the 70° parallel of north latitude; but while the ellipse of the American pole lies nearly in a North and South direction, that of the European pole lies nearly East and West. Mr. Smith is anxious to have mathematical assistance in projecting his ellipses upon a map or globe.

Prof. Houston desired the Society to make a note of some curious observations he had made recently while using Plucker tubes for obtaining the hydrogen spectrum, and modifying the internal diameter of their capillary tubes with a view to regulate the flow of the gas. In proportion as the resistance was increased, crimson spots and lines appeared, and finally the crimson color filled the entire space.

Pending nominations Nos. 792 to 802 were read, and balloted for, No. 793 being on motion postponed on account of the absence of the nominator.

The report of the Finance Committee was presented by Mr. Fraley, and the appropriations recommended by the Committee for the ensuing year, were on motion passed.

The ballot boxes being scrutinized by the presiding officer the following named gentlemen were declared to be duly elected members of the Society:

Col. Frank M. Etting, of Philadelphia.

Dr. Daniel C. Gilman, President of the Johns Hopkins University at Baltimore.

Mr. P. Cunliffe Owen, of South Kensington, London.

Mr. I. Lowthian Bell, of Newcastle on Tyne, England.

Mr. James Geikie, of Scotland

Prof. Thos. C. Archer, of Edinburgh.

Digitized by Google

Dr. Adolph Erik Nordenskiold, of Stockholm.

Mr. C. Juhlin Dannfelt, of Stockholm.

Mr. Elihu Thompson, A. M., Prof. Chemistry in the Philadelphia High School.

Mr. Charles V. Riley, President of the Academy of Sciences, St. Louis, Missouri.

And the meeting was adjourned.

Stated Meeting, May 5, 1876.

Present, 10 members.

Secretary, DR. LECONTE, in the Chair.

Visitors: Mr. Deby, of the Belgian Commission, and Mr. König, of Paris.

Letters accepting membership were received from Mr. Frank M. Etting, of Philadelphia, and Dr. D. C. Gilman, of Baltimore.

A letter declining the appointment to prepare an obituary notice of Mr. Cuyler, was received from Mr. H. M. Phillips, dated 1325 Walnut Street, Philadelphia.

On motion, Mr. Phillips was excused.

Letters of acknowledgment were received from the Regents of the New York University, and Boston Natural History Society (V ; 94).

Letters of envoy were received from the Secretary of the Geol. Survey of Pennsylvania, May 4 ; London Meteorological Office, R. S. April 8, and Royal Astronomical Society.

Donations for the Library were received from the Academies at Buda-Pest, Vienna and Bruxelles ; the Societies at Bonn, Göttingen, Ulm, Zurich, Geneva, and Cherbourg ;

Digitized by Google

the National Museum, and Geographical Society at Paris; MM. Rütimeyer and Alb. Müller at Basil; the Meteorological Office and London Nature; the Boston S. N. H.; Mr. E. D. Cope; Prof. O. C. Marsh and Silliman's Journal; the Franklin Institute; Academy of Natural Sciences; College of Pharmacy; Penn Monthly; the Manager of the House of Refuge; Dr. D. C. Gilman, of Baltimore, and Mr. S. S. Sherman, of Milwaukee.

The Committee to consider the propriety of publishing the medical theses presented at a previous meeting asked and obtained leave to postpone their report for another fortnight.

Prof. Frazer read a *resumé* of the important points in the memoir and maps of M. Delesse, entitled Lithologie des Fonds de Mer.

Prof. Frazer, also, made some preliminary remarks upon the possible effects upon species and genera of living beings to be supposed to arise from variations in the proportionate percentages of the chemical elements of their physical constitution, under the operation of the law of the "survival of the fittest," leading to the conclusion that, were the chemistry of organic bodies suitably modified, it might be possible for them to exercise the functions of life in otherwise destructive circumstances, as, for example, in solar heat. He postponed the reading of a paper which he had prepared on the subject to a future meeting.

The reading of the pending nominations, &c. was postponed, and the meeting was adjourned.

Digitized by Google

Stated Meeting, May 19, 1876.

Present, 11 members.

Prof. P. E. CHASE, in the Chair.

Mr. Selwyn and Mr. Carll, new members, were introduced to the presiding officer, and took their seats.

Visitors from corresponding societies, Mr. Honeyman and Mr. Lawson, of Nova Scotia.

A letter accepting membership (with photograph for the album) was received from Prof. Thos. C. Archer, dated Philadelphia, May 7, 1876.

Letters acknowledging the reception of publications were received from the Société Hollandaise, dated Harlem, February 1876 (XV ii, 94); the Foundation Teyler, dated Harlem (92, 93); the Statistical Society, London April 26, (95); the N. H. S of Northumberland, D. and N. upon Tyne, April 25, (95); the Royal Society of Edinburgh, February 21, (92, 93).

Letters of envoy were received from the S. Hollandaise March; Cent. Obs. St. Petersburg, March; Fondation Teyler, Harlem; and Department Interior, U. S., Washington, May 6, 1876.

Donations were received from the Royal Academy at Berlin; the Musée Teyler; Society of Anthropology and Revue Politique at Paris: M. LeComte Leopold Hugo, at Rome; the R. Geographical, R. Asiatic, and Chemical Societies and Victoria Institute at London; Nature; Radcliffe Observatory; M. Juhlen Deby: R. Society at Edinburgh; R. Dublin Society; Canadian Naturalist; Boston S. N. H.; State Board of Health, Mass.; American Chemist; Franklin Institute; Mr. John E. Wootten; Medical News; Second Geol. Survey of Pennsylvania; Department of the Interior and Engineer Department U. S., Washington; Dr. J. H. Kidder; Young Men's Association, Buffalo; and the Scientific Monthly at Toledo, Ohio.

Digitized by Google

The Committee to whom was referred the medical prize theses, reported.

Mr. Honeyman, by invitation, read a paper on the varieties of transported boulders found by him in the banks and "red heads" of the Nova Scotia shore for twenty miles east of Halifax, and along the harbor and railways to Winsor and Pictou; showing, by means of a colored map, and specimens containing fossils, and specimens of amygdaloid, agate, syenite, dolerite, diorite, granite, iron ore, &c., that the deposit at Halifax was the terminal and medial moraine of a glacier having its base along or behind the Cobequid mountains, 80 or 90 miles distant, and that the arc of collection and dispersion, of which Halifax was the centre of concentration, had an amplitude of 45°. The striæ on the rocks towards Halifax had an average trend of S. 5° E.; towards Windsor of S. 20°—30° E.; and towards Pictou of S. 25° W.

The thanks of the members present were warmly expressed by the presiding officer and others.

Professor Houston described some results which he had got with a Crooke radiometer in a good Geissler tube of his own manufacture, going to show that light was ancillary to heat in the action of the instrument. Presenting, however, non luminous rays of heat, as for example from heated copper, a small but decided motion was obtained. Moonlight gave no motion, but he intended to concentrate moonlight on the flags by means of a 16″ Fresnel lens.

Mr. Briggs reminded him that the thermopile revealed heat rays in the moonbeams, and an alum plate would be required to make the experiment satisfactory.

The minutes of the last meeting of the Board of Officers were read.

Pending nominations Nos. 793 and 803 were read.

On motion of Mr. Price, the Secretaries were instructed to reply to Mr. Kesselmeyer's letter, respecting the Calendarium, declining his proposals.

And the meeting was adjourned.

Digitized by Google

NOTE ON THE "LITHOLOGIE DU FOND DES MERS" OF M. DELESSE.

By Prof. Persifor Frazer, Jr.

(*Read before the American Philosophical Society, April 21st,* 1876.)

M. Delesse acknowledges his indebtedness to the treatises in Geology of Elie de Beaumont and Jas. D. Dana, in the first few prefatory pages. The following shows the scope and direction of the work:

I. Preliminaries. Methods pursued in studying the deposits. Orography of France and her submarine shores.

II. Principal agents of marine deposits.

Organic agents.

- Inorganic agents
  - External
    - Atmosphere.
    - Fresh and brackish waters.
    - The Sea.
  - Internal
    - Subterranean waters.
    - Eruptions.
    - Dislocations.

III. Marine deposits of the Coast of France. Shore deposits and submarine deposits. Distribution of Mollusks.

IV. Lithology of the principal seas of the globe. France. The ancient world. The modern world.

V. France at different geological epochs. Deposits of the ancient seas of France. Changes undergone by these deposits.

M. Delesse then describes his methods of investigation.

Fine sand is treated with hydrochloric acid, its loss of CO_2 determined, and this multiplied by 2.27 to obtain the carbonate of lime. This method is accurate enough. Magnetic iron is separated by a magnet. Part of the gangue comes out with the magnet. This augments the magnetic sand on the one hand; on the other much of the magnetic sand is not taken up; so that these two errors are on opposite sides.

Sands and gravels examined contained 0.54 to 2.70 p. c. of soluble material (sea salts and organic matter). Argillaceous sand has a tendency to remove salts from the water containing them.

The classification of the deposit was had without recourse to chemical analysis, by the microscope.

The sieve used had meshes with a diagonal of 1 mm. The universality of the presence of quartz is very striking. Even vegetable mould and that too resting on calcareous rocks show a notable proportion of quartz. Quartz is more abundant the more the waters are agitated.

The sand dunes of the coasts of France are mainly composed of hyaline quartz, whitish gray. They slope gently towards the sea at about 7°; landwards about 29° to 35°, and have been seen to advance in a high wind in spite of a heavy fall of rain 0.6 m in three hours. The absence of mud in dunes is noteworthy but easily explained, since this substance hinders the formation of dunes.

The minimum rainfall in France is in the region bordered by Troyes, Meaux, Compiègne, Epernay (40 centimetres).

Digitized by Google

On the Ain (one of the affluents of the Upper Rhone) it is over 120 centimetres.

Up the Seine from Paris about 28 p. c. of all the water which falls in whatever form finds its way into that river (within that hydrographic basin); 53 p. c. in the basin of the Saône near Trevoux. For the Garonne above Marmande and for the Auxois which flows over impermeable marls it rises to 65 p. c. The percentage increases in schistose and granitic regions.

It is noticeable that the rivers which flow over calcareous beds do not exhibit a large amount of limestone in their *débris*, as for example the Loire. This is attributed to the softness of calcareous fragments and their inability to resist trituritition. [It may be remarked that this explanation will only apply to the deposits at considerable distances from the edge of the calcareous formation, for otherwise the waste would be constantly renewed.]

400 metres from the mouth of the Lez the sandy deposits contain over 60 p. c. of carbonate of lime. At the mouth it consists of 23 p. c. carbonate of lime, with great numbers of flakes of green mica.

The Herault 600 m. from its mouth deposits a reddish gray gravelly sand, consisting of hyaline quartz with orthoclase, feldspars and granitic *débris*, much argillaceous schist, reddish brown mud, gray mica schist, greenish quartz, sand, and some tablets of silvery mica.

Magnetic sand is found here in large quantity and is derived from the igneous rocks over which the river flows.

These few notes will serve to convey an idea of how this part of the subject is treated.

By far the most striking, as the most valuable, part of M. Delesse's work is to be found in the elaborate charts which accompany it. The character of these charts as specimens of map printing is very high, although it is questionable if the condensation of a great number of unallied statistical facts upon one sheet is favorable to the easy comprehension of such charts. A better plan would be to reproduce the same outline several times with different and strongly marked coloration or shading than to construct all curves of every kind upon one frame work, thus causing them to cross and recross one another to the bewilderment of the eye. Another difficulty for the reader arises out of the method adopted by M. Delesse for conscientiously representing all his facts upon a single sheet. Had the several kinds of curves been strongly portrayed they would so attract and confuse the eye as to entirely destroy the effect of the map as a whole. To avoid this the lines have been made so exceedingly fine, that if any one try to follow one of these curves he will need either an exceptionally good eye or a magnifying glass; in either case the character of a *boundary* between a territory on one side and a territory on another fails; for the moment the observer seeks to take in the entire curve at a glance it becomes invisible.

The datum plane is sea level. Heights are registered in the metre curves and depths by similar means. But in approaching the mountainous regions of France, one half the contour lines are omitted, lest they should shade

Digitized by Google

these portions of the map too deeply to allow of the delineation of the other portions. The unnatural effect is produced, of a map constructed on two different hypsometrical scales.

The distribution of rock, sand, slime, etc. along those sea bottoms which have been best observed (as for instance in the British Channel and along the routes of various deep sea sounding lines) is very interesting.

The great distance to which fluviatile sediments are carried and the separate although adjoining areas which the suspended matters of two widely separated river systems will occupy is strikingly shown in the distinct belts of St. Lawrence and Mississippi sand which overlap for 500 miles along our coast without commingling.

For his contribution to our knowledge of our own coasts M. Delesse deserves the hearty thanks of every student of American physical geography and geology.

Mr. Lesley added his testimony to the great value of the work of M. Delesse, of which Prof. Frazer had spoken:

He hoped that the Lithologie du Fond des Mers would be translated into English, and the magnificent maps accompanying it republished for the use of American geologists. If only the one map of the American continent and its enclosing water-beds were published, showing by colors the different sediments which issue from our rivers, and are distributed by tidal currents along our coasts, it would be a most valuable addition to our handbooks of geology. Many of the problems of erosion and sedimentation in Mesozoic and Kainozoic times, are plainly helped to solution by this map.

One of the most striking features is the contrast between the sediment in front of the coast from Maine to Alabama, and that of the sediment filling the St. Lawrence Gulf, and tapering southwards to a point opposite Norfolk. The former sediment fills the in-shore angle of the Gulf of Mexico, in front of Pensacola; the latter is repeated as an outside belt, stretching from the mouth of the Mississippi to a point in front of Havana.

It is easy to see the cause of the difference. The inside sediment descends the rivers which drain the siliceous and feldspathic mountains of New England, New York and Pennsylvania, Virginia, the Carolinas and Georgia, composed of Azoic and Palæozoic formations. The outside sediment descends the St. Lawrence and the Mississippi, and represents the drainage of the argillaceous and calcareous interior of the continent, composed of the Sub-carboniferous limestone formations east of the Mississippi, and of the broad stretches of Cretaceous and Tertiary rocks between the Mississippi and the Rocky Mountains.

The map suggests plainly the cause of the difference between the constitutional features of the eastern and western Cretaceous and the eastern and western Tertiaries.

A thousand details of this nature will repay the student of the map, to construct which must have tasked the zeal, as well as the knowledge, of the distinguished French geologist, its author, to the utmost.

M. Delesse is naturally desirous that this map should be known to American geologists, and to receive from them, directly or indirectly, such criticisms of it as will enable him to improve it in future editions.

Digitized by Google

THE GLACIAL EPOCHS.

By Eli K. Price.

(Read before the American Philosophical Society, March 3, 17, and April 3, 1876.)

The Geologists speak of the Glacial Epoch, with a ready confidence that implies they consider it an admitted doctrine of their science; and they mean by "the glacial age," one of continental ice sheets. Glacialists have written large volumes on the subject, and its literature is swelling into a library. Agassiz, born and educated among the Alps, studied their glaciers and their effects, and traveling thence, applied his theories to other parts of the world. He was very sincere in his convictions, and complained that so few of his colleagues accepted his views; but in the confidence that he held a great truth he was willing to abide the coming of the time he foresaw, when Geologists would generally accept his theory. That time seemed to have arrived before he died, with some distinguished exceptions.

Those who have made Geological Surveys of England and Scotland, and parts of the Continent of Europe, either as conductors of public Surveys, or as Professors in colleges, or teachers through the press, find the ready explanation of what they see, in the doings of the great Glacial Epoch, when the supposed Northern ice-sheet filled the Arctic Ocean, the British and Irish Seas, and covered Northern Europe continuously over land, rivers, seas and mountains, to shed its icebergs far out into the Atlantic. And so too in this broad country, the Geologists who have made our public Surveys, who teach in our colleges, or publish, have generally read the rocks and drifts in the same way, in making explorations that have extended over the length and breadth of this continent.

Geologists, as other scientists, must follow the truth as the facts of nature compel them. Truth's compulsion is as inexorable as the pressure of the gigantic ice-sheets, these glacialists suppose, bore down from the pole. But they, as others, must often review their facts before they accept a theory as conclusive, and make themselves sure that they have not, by an engrossing attention to limited facts, overlooked others which should have influenced their theorizations.

They teach that the Glacial Epoch has occurred twice at least, since the rocks were laid in the strata as we see them; long after the coal measures were formed; of which the evidence is to be found upon the surface of the rocks as they now exist, and in the clays, and drifts, and boulders now spread over those rocks. Geologically speaking, these phenomena are of recent date, although before the Niagara began to cut the channel we now see. The astronomical cause assigned for them gives them a periodicity of about twenty-one, to twenty-two thousand years, and our northern hemisphere the respite of the half of such period, before it shall again be ground into paste.

Digitized by Google

We have the deepest interest, as a truth of science, to know what have been the causes that have deeply modified the surface of the world we inhabit; and a yet deeper interest in knowing what shall befall that part of the northern hemisphere now occupied by the most intelligent and civilized portion of mankind, with their wealth, cities, cultivation, and works of transportation and travel; for if the theory be true all these will be ground into the comminution of the boulder clay that flows from beneath the glacier of the Alps! When men pay for real estate they exact an extreme scientific care that they get a fee simple title forever, Why be so anxious, if all is to be razed, leaving them an interval of but a term of years. Yet more; we cannot but sympathize with a posterity destined so to perish; and with the shock to the faith of those who believe in a Creator, capable, and willing to conserve His creation.

Let us then see what this supposed continental ice-sheet is. Listen then to the very words of Agassiz, author of the theory: "It is a sheet of snow ten or fifteen thousand feet in thickness, extending all over the northern and southern portions of the globe; and must necessarily lead, in the end, in the formation of a northern and southern cap of ice, moving to the equator." Speaking of the northern, Agassiz further says: "As to the southward movement of an immense field of ice, extending over the whole north, it seems inevitable, the moment we admit that snow may accumulate round the pole in such quantities as to initiate a pressure radiating in every direction," "alternately thawing and freezing, it must, like water, *find its level* at last." "In the State of Maine, I have followed, compass in hand, the same set of furrows, running from north to south in one unvarying line over a surface of one hundred and thirty miles from the Katahdin Iron Range to the shore. These furrows follow all the inequalities of the country, ascending ranges of hills varying from twelve to fifteen hundred feet in height, and descending into the intervening valleys two or three hundred feet above the sea, or sometimes even on a level with it." (A Journal to Brazil, 403, 402.) These all are words of Agassiz, with no word of apprehension or sympathy for his fellow beings, for whose welfare the noble labors of his life were devoted.

Agassiz gives further explanation of his views on the "Ice period in America," in the *Atlantic Monthly* for July, 1864. The ice moved over the continent as one continuous sheet overriding nearly all the inequalities of the surface, p. 88. Fragments of rocks from Lake Superior are found in New England, and northern rocks on the prairies of Illinois and Iowa, down to the fortieth degree of latitude. Polished rocks and straight scratches may be seen for hundreds and hundreds of miles. The slopes of the Allegheny range are glacier-worn to the very top, with the exception of a few points. Mount Washington is over six thousand feet high and wears glacier marks to near its summit. Here the thickness of the sheet could not have been less than six thousand feet. If much lower than that the ice passed over the mountains. He asks us to imagine the climate of Greenland brought down to the fortieth degree of latitude, with ice thousands of feet thicker

Digitized by Google

than it is there at present. Norway, Sweden, Scotland, England, Ireland, were so covered, p. 92. This, it is true, was long ago: yet late cave explorations are supposed to indicate, that the latest glacial epoch was since man inhabited the earth.

Professor Winchell, adopting the glacial theory, states its causes and effects. He rather delights to make science sensational and astonishing. "The high northern latitudes experience an *unwonted uplift.* Arctic lands raise high their dripping heads above the temperate waters of the polar zone. The climate of the whole northern hemisphere feels the change. No moving currents can now bear torrid warmth to the frozen sea, and return the colder waters to the equatorial zone." "The snows of many winters are gathered on the slopes of Northern America." "Glaciers brood over all the land." "The marks of this stupenduous glacier are yet visible." "The northern limit was chained by eternal frost to its rocky bed. The southern only was free to move, and the whole expansion would be developed along the southern border." (Sketches of Creation, 214.) "From season to season, and from year to year, the mighty mass marched irresistibly forward, mowing down the forests, crushing tree-trunks, or burying them with the rubbish of the rocks, from ten to sixty feet below the surface." "The great glacier moves onward." "It bridged Niagara River; it bridged Long Island Sound, and bathed itself in mild waters of the ocean beyond," p. 218. 219. "It made a *tabula rasa.*" River channels were filled up; "In Ohio and Indiana these buried river-beds are of frequent occurrence. The ancient gorge of the Niagara River was filled by the obliterating agency of this continental glacier." "It wiped out the trifling furrow, * * making it necessary for the river to begin anew its work," 219, 220. It bore rocks southward twenty, fifty, and even five hundred miles. "These fragments have been transported over lakes, sounds and seas." The glacial agency is not recognized south of the Ohio River, 220, 221. The south was spared; nay, greatly favored; for except the chain of mountains, the material ploughed up by the ice was carried by the waters to make the Cretaceous seaboard, the Gulf states and the many more of the Mississippi, and Missouri valleys.

This reign of ice came after the close of the carboniferous age, and after the land was upraised and dry, and vegetable and animal life existed on it as now, except that man was not yet here. Winchell is so speaking (219, 213), and then says, "Next in the order of vicissitudes was a grand continental subsidence. Vast areas of Northern America, that had been raised to the altitude of perpetual snow, were gradually lowered to the ocean's level. Again the interchange of equatorial and polar temperatures was affected by the moving sea-currents, and the climate of summer smiled over the desolate empire of frost," 222. "By degrees Wisconsin, Michigan, New York, Ohio and other Northern States disappeared beneath the waves," p. 228. "It seemed like a failure of the plan of creation. The land gained by *unnumbered throes* of the continent was lost. The higher summits only held their heads above the level of the careering

Digitized by Google

waves. Deposits bearing the marks of oceanic action reach to an elevation of six thousand feet on *Mount Washington, two thousand* or more on the Green Mountains, and *three thousand* on Monadnock. But this deep submergence was not of long continuance. Slowly the continent rose again from its deep sea burial," 229. Thus the continent here, as we shall see in Europe, seems to rise and fall thousands of feet at the bidding of theorists.

The Ohio Geological Report of 1873, written by Dr. Newbury, is equally threatening; 1 vol. 85: "The period immediately following the Tertiary age in geological history, but separated from it by we know not how many thousands of years, presents us with a complete change in the physical condition not only of our own continent, but apparently of the whole northern hemisphere; a change not exceeded by that which takes place upon our surface in the alternations of season from mid-summer to mid-winter. We have abundant evidence that during what is called the drift period the climate of our continent had changed from the all pervading warmth of the Tertiary to an all pervading arctic cold. While in the former age the climate of our Southern States was carried to Greenland, in the latter the *present climate of Greenland was brought as far south as the Ohio*. The continent of Greenland is now nearly buried under snow and and ice." "Precisely such must have been the condition of much of the North American Continent during the glacial period, for we find evidence that glaciers covered the greater part of the surface down to the latitude of 38 or 40 degrees." The smoothed and grooved rocks are covered with the glacial drift deposits; and upon and mingled with it, is the Erie clay; deposited from suspension in water and stratified; doubtless from basins where had been the retreating glaciers, p. 86.

If geologists did not produce so many restorations of the past, full of wonderful instruction, we would be apt to say that surely the imagination had large operation in making such confident explanations of the past doings of Nature upon this globe. Grand, sublime, were and are her operations; but one cannot help thinking if they could be seen that their progression was slow and orderly, without extreme vicissitudes, and as harmless as we now see them. There was ample time for the work; and Geologists readily allow any amount needful for observed effects, counting a thousand years as a day. The sedimentary rocks show that the process was generally a quiet one, the more modern with fewest faults; and certainly nothing could have been more carefully done, than the manner of the growth and storing away of the coal and oil, under their rocky coverings for the use of the human beings that were to occupy the world. Excepting the ventilating volcanoes, and the mountain-heaving earthquakes, the elevations and depressions of the earth have been at the rate of but a few feet in a century, so that it can hardly be soberly said that the land was gained by "unnumbered throes." Nay the probability seems to be that the concurring operation of the sinking of the sea beds and the raising up of the mountains, the one balancing the other, were then as now, only to be gauged by the lapse of the centuries, so quiet and imperceptible were they. Geology

Digitized by Google

has no chronology of years, but only of the order of its own successions, and the preparations, in the "beginning" of this earth, for man, there is every evidence was very long, and not violent.

James Geikie writes in more measured and careful language than any of those who have lately written on the Glacial theory; and he may, therefore, be allowed to be its reliable expositor. Writing "The Great Ice Age," he says, "We must believe that all the hills and valleys were once swathed in snow and ice; that the whole of Scotland was at some distant date buried underneath one immense *mer de glace*, through which peered only the higher mountain-tops. This is no vague hypothesis, or speculation founded on uncertain data, no mere conjecture which the light of future discoveries may explode. The evidence is so clear and so overwhelmingly convincing that we cannot resist the inevitable conclusion." p. 82. "Now the scratches may be traced from the islands and the coast-line up to the elevation of at least 3,500 feet; so that ice must have covered the country to that height at least." 83. Agassiz added one-third to the height scored, that the ice-sheet might have a back pressure to pass it over the elevations. "Such changes happened not once only, *but again and again*," says Geikie, 200.

Of North America, Geikie says, It is no exaggeration to say, that the whole surface, "from the shores of the Arctic Ocean to the latitude of New York (City), and from the Pacific to the Atlantic, has been scarped, scraped, furrowed and scoured by the action of ice." 411.

And the conclusion of Geikie's Great Ice Age is this. "Upward of 200, 000 years ago the Earth, as we *know from the calculations of astronomers*, was so placed in regard to the Sun that a series of physical changes was induced, which eventually resulted in conferring upon our atmosphere a most intensely severe climate. *All Northern Europe* and *North America* disappeared beneath a thick crust of ice and snow, and the glaciers of such regions as Switzerland assumed gigantic proportions. The great sheet of land-ice leveled up the valleys of Britain and stretched across our mountains and hills down to low latitudes in England." And so it is said as to the north of Europe. "Ere long this wonderful scene passed away. Gradually the snow and ice melted; the arctic mammalia disappeared; the climate grew milder, until something like perpetual summer reigned in Britain. Then it was that the hippopotamus wallowed in our rivers, and the elephant crashed our forests; then, too, the lion, the tiger, and hyena became denizens of the English caves." Then after a "long time" it grew cold; these tropical animals disappeared, and the arctic beasts came back; but the climate became so severe that even these "migrated southward, *until all life* deserted Britain, and snow and ice were left in undisputed possession. *Once more* the confluent glaciers overflowed the land, and desolation and sterility were everywhere." "We cannot say how often such alternations of cold and mild periods were repeated." "A similar succession of changes transpired in North America." The palæolithic man was here in the inter-glacial period, and frozen out! 534, &c.

Digitized by Google

In Scotland "the direction of the scratches, ruts, and grooves upon the rock head, usually *coincides with the trend of the valley* in which the till occurs." Geikie's Ice Age, 21. "In the Northern Highland * * they keep parallel to the trend of the great glens; and in the Southern Uplands, likewise, they follow all the windings of the chief dales and 'hopes.'" p. 80. A hope is a sloping plane between ridges of mountains. Let us remember these local indications.

And James Geikie asks, "What do we learn from the erratics?" the far-traveled blocks over the whole face of the country. "The highland boulders on the Pentlands and Lammermuirs, for example, after crossing Strathallan or Strathearn, traversed either the Campsie or Ochil Hills, and passed athwart the broad vale of the Forth before they finished their journey. By what agent were they transported? The answer is by a colossal glacier." p. 223–4. "It is a fact that most, if not all, the *erratics* have traveled in directions that coincide with the *trend of the rock-striæ.*" "The erratics lying loose upon the ground have moved in the identical direction, followed by the till of the same regions; a direction which it need hardly be said coincides with that of the underlying rock-striations. Indeed, when the *till* is carefully searched it not infrequently *yields fragments of the same rocks* as those of which the erratics lying *loose at the surface* are composed." 224–5. Mark how coincident with the topography.

He further proceeds to say, that after the great glacial deposits of Scotland, "the country at length became submerged to a depth in the south-east and west midland district of probably as much as 1,100 or 1,280 feet." 353, 255. "The river deposits of the lowlands were *now partially re-assorted*, or top-dressed, as it were, by the action of the sea. As the submergence approached its climax the temperature became colder; *ice-rafts floated about*, and *dropped boulders over the sea-bottom*. These are now found floating on the slopes of the reassorted gravels, and enclosed in stratified clays, the character of the shells in which prove the climate to have been severe." 353.

Mr. J. Geikie finds in England, Wales and Ireland the like evidence of glaciation, of depression of the land and inflow of the sea, and the elevation again of the land; but no true *till* has been found in east Anglia. 371. "The striæ upon the rocks, and the direction in which the till has traveled, mark out clearly the path taken by the great sheet of ice which wrapped up Ireland even as it enveloped Scotland." 373.

Scandinavia, Northern Europe generally, Switzerland, the Vosges, Black Forest, and Pyrenees, bear evidence of former Arctic conditions. "Even as far south as latitude 37°, the former existence of glaciers in the Sierra Nevada has been proved;" * * "and so on with most, or perhaps all, the hillier regions of Europe, great snow fields existed where now there are none," or but "insignificant successors." 379. And the like account is given on the testimony of travelers of Caucasus, Atlas, Lebanon, the Himalaya, and mountains in the north of China and in North America. "The direction of the glaciation in the extreme north of Scandinavia, the

Digitized by Google

peninsula of Kola, and Northeastern Finland demonstrates that the great *Mer de glace radiated outwards from the high graunds* of Norway and Sweden, flowing *north and northeast* into the Arctic Ocean and east into the White Sea, and thus clearly proving that Northern Europe was *not overflowed by a vast ice-cap creeping* outward from the North Pole, as some geologists have supposed." 382. These are Geikie's words; and here he is at issue with James Croll and Agassiz.

Geikie proceeds: "After that boulder-clay had been laid down, dry land appeared in Scotland and the north of England; and at a later date, a movement of subsidence ensued which resulted in drowning Wales to a depth probably of not less than two thousand feet." "All we know is that Scotland, Wales, and the north of England were largely submerged." Geikie, 479. The south and southeast of England was not submerged, and that portion only contained paleolithic instruments; but the neolithic occur everywhere in and throughout the British Islands; 480; and here were no traces of glaciation; 479; the line of division being the middle of England; 484. The islands and continent became connected; 485.

He says: "It is remarkable, that nowhere in the great plains of Siberia do any traces of glacial action appear to have been observed." Ib. 495. "Consequently we find the great river deposits with their mammalian remains, which tell of a milder climate than now obtains in those high latitudes, still lying undisturbed at the surface." 496.

In the regions of Alaska, west of the Rocky Mountains we have, says James Geikie, "a continuation of the same physical conditions that characterize the more northern latitudes of Asia, namely, great plains intersected by large rivers. Along the banks of these rivers, north of Mount St. Elias, numerous mammalian remains, especially the mammoth, have been detected." "But in the northern latitudes, east of the Rocky Mountains, no such mammalian remains have been detected." "They are rare also or altogether wanting in Canada." "Nevertheless, proofs are not wanting of a former mild condition of things having prevailed within comparatively recent times in the far north of British America." 497.

The glacialists generally find no cause for the great ice sheet, whose effects they see, in the elevation of the mountains, or in ice floods, nor in ice rafts floating from the pole. Mr. James Croll finds its cause in the earth's movement in an elliptical and eccentric orbit round the sun, which is central to one end of the ellipse, so that when the earth moves in the other end of the ellipse it is three millions of miles farther from the sun, and in the extreme of the orbital eccentricity he says fourteen millions of miles further from the Sun; and by reason thereof the warmth of the Sun is lessened at its surface. At this time the Earth is nearest the Sun at our mid-winter, and our winter solstice is supposed to be warmer for it; but by the precession of the equinox, the Sun crosses the equator twenty minutes and twenty seconds sooner than the year before; Geikie 129; by which process our seasons become gradually shifted in relation to the position of the Earth in its orbit, so that in ten thousand five hundred years our winter

Digitized by Google

solstice will coincide with the Earth's greatest distance from the Sun; 130; hence, greater refrigeration; and hence, according to Jas. Croll, a great ice cap at the North Pole; to be yet more aggravated when such coincidence shall occur at the greatest eccentricity of the Earth's orbit. It is not asserted that in any one year the Earth will receive any less heat from the Sun, or in either hemisphere than in the normal state of the Earth's movements. If the aphelion winter be colder, the perihelion summer would be warmer in the same hemisphere. At the present time these both occur in the southern hemisphere, and we hear of no abnormal cold, or increase of ice. Certainly South America is not invaded by ice, and our ships are going round Cape Horn as usual. It is not known that the glaciers on the Andes have grown higher or longer; while it is known that by the rise of Norway of but three feet in a century, the mountain glaciers have grown longer by about three hundred yards. The good people there need not be in a hurry to emigrate, for in due time the vertical oscillation will be in an opposite direction.

Agassiz says, in his Journey in Brazil, in proof of his opinion, "On my arrival in Rio de Janeiro, * * * my attention was immediately attracted by a very peculiar formation consisting of an ochraceous, highly ferruginous, sandy clay. During a stay of three months at Rio, whence I made my excursions into the neighboring country, I had opportunities of studying this deposit, both in the province of Rio de Janeiro and in the adjoining province of Minas Geraes. I found that it rested everywhere upon the undulating surfaces of the solid rocks in place, was almost entirely destitute of stratification, and contained a variety of pebbles and boulders." p. 299. "There can be no doubt in the mind of any one familiar with similar facts observed in other parts of the world, that this is one of the many forms of drift connected with glacial action. I was, however, far from anticipating, when I first met it in the neighborhood of Rio, that I should afterwards find it spreading over the surface of the country from north to south and from east to west, with a continuity which gives legible connection to the whole geological history of the continent." p. 400. "A sheet of drift, consisting of the same homogenous, unstratified paste, and containing loose materials of all sorts and sizes, covers the country." p. 403. Up the coast at Pará, he says, "I was surprised to find at every step of my progress the same geological phenomena which had met me at Rio," and he was reliably informed "that this formation continued through the whole valley of the Amazons, and was also to be found on all the affluents." p. 405. Now Rio is at the 24th degree of south latitude, Pará at one degree, and the Amazon discharges under the equator. Did then the polar ice cause the phenomenon? If so, was it by a mighty continuous land-borne glacier from the South Pole, or by ices from the Andes, glacial or floating? He gives no explanation here, but elsewhere regards the Andes as sources of the glaciation. He saw the unstratified paste "spreading over the surface of the country." Other geologists, in other parts of the world, find its supposed equivalent, the "boulder clay or till," at the bottom of the drift

Digitized by Google

formation, and long antecedent in deposition. But there is no reason why the paste should not be formed through all time, where there are mountain glaciers, grinding the rocks of the descending defiles, with a water underflow, frosts and rains, to spread it over the lower country, to an indefinite extent through indefinite time.

There certainly seems to be no warrant for the supposition of a polar ice-sheet over South America, while a cause for the phenomena seen seems much nearer. There are the Cordilleras, ever ice-covered, with valleys filled with glaciers grinding upon the rocks, and making paste or Till of their comminuted materials, and incessant freezings and thawings and rains to carry down the product over the *surface of the land*, now as well as when the first drift deposit was made. Further information is certainly wanted upon this subject, and it may be hoped that Professor Orton, now about to visit the Amazon, may afford it. Mr. Kerr, in his Report on the Survey of North Carolina, in 1875, makes observations pertinent and interesting: "Till or initial drift," which "may be seen everywhere on the hills and slopes of the Piedmont region, and less conspicuously, even in the eastern territory of the Quarternary proper." p. 157. "Evidently these materials" (the gold gravels) "have descended the slopes of the mountains and ridges, at whose bases, or on whose lower and gentle inclines they are found. By what force? Certainly not of water. Neither are they moraines; accumulations at the foot of descending ice masses. They are simply beds of *till*, which have crept down the declivities of the hills and mountains, exactly as glaciers descend the Alpine valley, by successive *freezing and thawing of the whole water-saturated mass, both the expansion of freezing and gravitation contributing to the downward movement;* and with each thawing and advance, the embedded stones and gold particles dropping a little neare the bottom." p. 156. This idea may explain much of the appearances that perplex geologists, without driving them to the theory of an immense polar ice-sheet glaciation. All past time, since the mountains rose from the sea, gives room for normal causes to complete their work, with the results we witness; and account for Till being found upon the surface as well as beneath the drift, and that without a polar ice-sheet.

Those who concur in the conclusion that there have been continental ice-sheets of great thickness, and destructive of all life where they moved, are not agreed as to their cause, source, or extent. Agassiz insists that their cause is cosmic, and more than the normal glaciers of high mountains; and he and James Croll, and Winchell, and others, give them a polar center and a flow towards the tropics down to at least the 39th degree of latitude, and Agassiz extends them into the tropics. James Geikie, with Croll, ascribes to them an astronomical cause, but makes the mountains of Norway and Sweden the source and center of the ice-distribution. Winchell infers a mountain at the North Pole adequate to the production and movement hither of the great ice-sheet. This want of accord among these eminent glacialists is an argument of considerable force to show that the theory is without a tenable foundation.

Digitized by Google

Beside, the theory is so extraordinary, in its conjectured cause, and so stupendously disastrous in its consequences; and so wholly at variance with the ordinary procedures of Nature, that mankind have a right to take their stand on the stability of normal laws, and to demand the clearest and most indubitable proofs, before they yield their faith in all they have been taught by experience and history.

Uniformity between cause and effect; stability of law; are the basis and surety of all philosophizing. Building on such foundation mankind have believed that this earth is their stable habitation, since man was placed here, and that it is neither to be drowned nor ice-clad, to the destruction of the life upon it. We reasonably infer from all the past that the world was made to support the life it sustains; that the Power that could create both it and that life, and adapted one to the other, had a purpose of their permanence, and would not permit that purpose to become frustrate. Against such an inference, based in all knowledge of what has been, they who assert an impending liability to the destruction of half or more of the human race, with its wealth and civilization, have a right to demand an attesting example in the world's geological history, or reasons more cogent than seem to have been offered, to prove that such destruction awaits the world.

They have a right to say that so general a disaster is not compatible with the established order of the universe. Those who offer an hypothesis, the converse of this ground of security, have the burden of the proof and of the argument resting heavily upon them. The facts they rely upon must be clearly incapable of any other solution; the cause assigned must fit the effect.

All physicists profess to adhere to the normal laws of nature; as the law of gravitation, the movements of the planets, &c., the formations of the rocks, their elevations and depressions; of evaporations, and rainfalls, and congelations, &c.; and he who rests himself on such foundation is to be taken to be upon the true foundation, until it is clearly shown that some eccentricity of nature has been acting exceptionally, and has left the evidences of her exceptional action in manner to be incapable of explanation by her usual laws. Adhering to these laws geologists have generally agreed that in the beginning this Earth was very hot and that its interior was the source of igneous rocks; that it was surrounded by water and steam; and in the pervasive waters the sedimentary rocks were deposited from the eroded materials of igneous rocks, and by incessant repetitions of the erosions of both kinds of rocks, and that as late as the Carboniferous Ages the Arctic had yet a Tropical climate. By heat the Earth was kept expanded, but cooling by radiation it gradually grew less, and the crust of rock became too large for the internal mass, and consequently by its own weight the collapse sunk the valleys and raised the hills, formed the ocean beds and heaved the mountain ranges, and the Earth's rocky covering became plicated and corrugated, yet by a process as gradual and quiet as the radiation of the internal heat. This process was onward until its cause ceased; but the cessation of the radiation was no cause for a glaciation

Digitized by Google

greater than we witness. By the impulse that produced the rotation of the Earth on its axis, the shape of the globe was reduced from a sphere to an oblate spheroid, by the flattening of the Poles, and that cause forbade mountains rising at the Poles. It is necessary that we keep the above principles and facts in view as we proceed. The height of mountains, and seas open to the Poles are both causes of glaciation, and not to be overlooked, but cannot be cause of the continental ice-sheet.

Having stated the theory of the great glacial ice-sheet, and the facts upon which the glacialists place it, it seems expedient, considering how generally it has been accepted, to take yet closer and broader views of other facts and laws requisite to correct conclusions, many of them furnished by the glacialists themselves, but looked at by other eyes, these may afford proofs that should conduct to an opposite induction.

The *unstratified drift*, or boulder clay, or Till, is a chief argument for the continental Arctic sheet of ice. Grant it came from beneath ice, that fact does not prove that it came from a polar ice-sheet, for it might be from glaciers of contiguous mountains, or ices floating down from the North. Dr. Dawson say: "It may be viewed as consisting of a base or paste including angular and rounded fragments of rocks. The base varies from a stiff clay to loose sand, and its composition and color generally depend upon those of *the underlying and neighboring rocks*. Thus, over sandstones it is arenaceous, over shales argilaceous, and over conglomerates and hard slates, pebbly or shingly. The greater number of the stones contained in the drift are usually like the paste containing them, derived from the neighboring rock formations." Acadian Geology, 59. In Brazil it is "ochraceous, highly ferruginous, sandy clay." Agassiz, 399. This is evidence that the source of the Till is local and co-extensive with a local cause and source; but as the Andes are of immense height and running the length of South America and covered by perpetual glaciers, so the manufacture of the paste is present through all time; and the frosts and rains have ever since the Cordilleras were raised, spread it over the declining surface towards and to the Atlantic. With this eternal winter ever present upon the Andes, even under the Equator, it does not seem necessary that we should seek a cause in a great "cosmic winter," "of universal cold," which may have lasted "for thousands of centuries," for so much Agassiz says. We need not then go to a polar ice-cap for an explanation. The Till may be there from normal causes, and thus be yet spreading over the surface.

Agassiz rejects the idea of deposition under the sea, because there are no marine remains in the strata of rocks or their covering. He says: "It is my belief that all these deposits belong to the Ice Period in its earlier or later phases, and to this cosmic winter, which, judging from all the phenomena connected with it, may have lasted for thousands of centuries, we must look for the key to the geological history of the Amazonian Valley. I am aware that this suggestion will appear extravagant, but is it, after all, so improbable, when Central Europe was covered with ice thousands of

Digitized by Google

feet thick; when the glaciers of Great Britain ploughed into the sea, and when those of the Swiss Mountains had ten times their present altitude; when every lake in Northern Italy was filled with ice, and these frozen masses extended even into Northern Africa; when a sheet of ice, reaching nearly to the summit of Mount Washington * * (that is, having a *thickness* of nearly six thousand feet,) moved over the *continent* of North America; is it so improbable that, in this epoch of *universal cold*, the Valley of the Amazons also had its glacier poured down into it from the accumulations of snow in the Cordilleras, and swollen laterally by the tributary glaciers descending from the table lands of Guiana and Brazil? The movement of the immense glacier must have been eastward, determined as well by the vast reservoirs of snows in the Andes as by the direction of the valley itself. It must have ploughed the valley bottom over and over again, grinding all the materials beneath it to a fine powder, or reducing them to small pebbles; and it must have accumulated at its lower end a moraine of proportions as gigantic as its own; thus building a colossal sea wall across the valley." p. 425. But he found no striated stone as there was no natural rock-surface in the valley; and admits "I have not here the positive evidence which has guided me in my previous glacial investigations." p. 426.

All this account of the Amazonian Valley is inconsistent with what Mr. Agassiz had, in the same Journal, 403, said of a Northern and Southern Ice-cap "moving to the Equator," and with all the other glacialists who claim that it did not descend below the thirty-ninth degree of latitude. This gigantic glacier certainly did not come from the South Pole; nay, when in the stage of thawing, it did not move at all. It was dammed in by its own moraine or huge wall of *débris*; and when it melted it became a vast fresh-water lake. And Agassiz says: "In this shallow sheet of water under the ice, and protected by it from any violent disturbance, those finer triturated materials always found at a glacier bottom, and ground sometimes to powder by its action, would be deposited and gradually transformed from an unstratified paste containing the finest sand and mud, together with coarse pebbles and gravel, into a regularly stratified formation." Ib. 428. This is said to explain why this is not like the same glacial product in Europe; why it is stratified as a deposit of still waters, but does not explain how the same material has a different appearance over the general surface of Brazil; how the trituration and stratification would go on without motion of both ice and water, nor what, during such quiet lake-like operation under ice, had become of the floods that were ever descending from the greatest water shed of the world which must reach the sea. The attempted theory demands too much, involves difficulties not cleared up, and stands upon another basis than that of polar glaciation. That the floods of the Amazon and all its tributaries should be self-dammed into a lake of fresh water, and, at near the sea level, covered with ice under the equator is a proposition that seems of the most extraordinary nature, and self-condemning.

Digitized by Google

Let us proceed to examine other witnesses for additional facts, and compare other opinions of the scientific experts, though it be to find them expressing conflicting views, as they are wont to do in courts of justice, when it becomes the duty of the judge to extract the truth as well as he can, by principles of reason applied by good sense. The testimony will keep in view not only the facts of glaciation, but also those which show that there were other causes for all the phenomena we witness less abnormal than that assigned by the eminent naturalist whose name gave authority to all his utterances. If a continental ice-sheet of the magnitude supposed could not travel hither from the North Pole by land, there may have been water-ways for ice to float down from the Arctic region, and also local glaciers from higher mountains where none are now to be found, or those of much smaller size.

If the glaciation was cosmic, polar and continental, then should Northern Asia bear evidence of it. James Geikie claims to include North America, but does not claim Siberia as having been subject to the reign of ice. He says: "Thus, in the Western as in the Eastern Hemisphere, we are confronted with precisely the same phenomena. In regions which can be proved never to have been over-ridden by the great continental glaciers, and in districts which give no evidence of submergence during the latest period of glacial cold, the extinct mammalia occur in less or greater abundance at the very surface." Great Ice Age, 501. He further says the north coast of Asia "indicates the former presence of a milder climate in Siberia than now," "in the presence of numerous animal remains," as of the "mammoth, wooly rhinoceros, bison and horse." p. 495, 496. "The great plains of Siberia never could have nourished glaciers." "The absence of high grounds, and the comparative dryness of the climate, must have prevented any accumulation of glacier ice." 502. And he only claims that the great glaciers extended southward to the middle of England. Yet to fill the conception of Agassiz and Croll the ice formation at the North Pole should have so filled the Arctic Ocean as to move by its weight over the land of Northern Asia, as well as over Europe and America. The land journey should have been the same over the three continents from the same mountain of ice at the North Pole.

Next to the boulder clay, the scratches and groovings in the rocks are taken as the proofs of the Polar ice-sheet. Their straight northerly direction affords the argument.

Dr. Dawson, an eminent practical geologist, who has observed by travel and reflected much upon the subject, rejects the theory of the great ice-sheet from the far north. The scratchings are not from one direction, but some from nearly north, some from north 20° and 30° east, north 20°, 25°, 30° and 65° west. Acadian Geo. 62; 69. In the St. Lawrence Valley the direction is from northeast to southwest. At Stony Point, Lake Erie, Michigan, the grooves are from north 60° east, and from north 60° west. Winchell, 218. Dana gives greater variations, showing variations and hitches in the moving mass. 589, 751. And Henry D. Rogers said, the

Digitized by Google

grooves crossed at various angles, and "the striæ are, moreover, not rigorously straight, but curve slightly to conform to inequalities in the shape and hardness of the resisting surface." 2 Geo. of Penna., 775.

Dr. Dawson says: "I have no hesitation in asserting, from my own observations as well as from those of others, that for the southwest striation the direction was *from the ocean toward the interior*, against the slope of the St. Lawrence Valley. The crag-and-tail forms of all our isolated hills, and the direction of the transport of boulders carried from them show throughout Canada the movement was from northeast to southwest. This at once disposes of the glacier theory for the prevailing set of striæ, for we cannot suppose a glacier moving from the Atlantic up into the interior. On the other hand, it is eminently favorable to the idea of ocean drift." 69. This was based upon the idea of a submergence of Canada, New York, and New England, and an Arctic current bearing ice in the forms there produced. He proceeds to say: "Now we know that in the Post-pliocene Period, Eastern America was submerged, and consequently the striation at once comes into harmony with other geological facts." 70.

Dr. Edward Hitchcock, in his address in 1841, says: "The group named post-tertiary by Mr. Lyell, is found also in the northern part of New York and in Canada, containing shells of a more Arctic character than those now living in the same latitudes." p. 18. To produce the drift, scratchings, and transportation of boulders witnessed, the agents must have been water and ice, exerted before the existence of man on the continent; yet geologically recent; but he did not pronounce his belief in the great ice-sheet. 22, 23.

Professor Rogers says: "From the coast of Maine westward to the basin of Lake Ontario, and from the estuary of the Hudson northward to that of the St. Lawrence, a deposit of blue clay and sand occupies the valleys of many of the rivers at all levels above the tide and to a height of more than four hundred feet in the Valley of Lake Champlain, where its elevation is at its maximum." And speaking of the later local drift, he says: "No one general direction or northern source can be assigned to this upper deposit, *its gravel and erratic blocks appearing rather to be derived from the more ancient general drift of the adjoining hills, redispersed by some aqueous movement upon the surface of the fossiliferous clays and sands.*" 2 Geo. of Pa., 775.

To proceed with our survey geographically from east to west. The Geology of New Jersey by George H. Cook presents us with some relevant information. He says: "After the process of deposition had ceased, the whole of this ancient shore has been elevated to nearly four hundred feet above the ocean level. This has taken place bodily." But, "Some powerful agency like that of water, or water and ice, has swept over the whole country, and has worn down its surface in gullies, valleys, or broader intervals, sometimes to the amount of three or four hundred feet." p. 285. He gives twenty-four observations of scratches on the Traprocks. Of seven on the Palisades their course is south 20 to 40 degrees east; Bergen

Digitized by Google

Neck southwest and southeast; south and west of Patterson south 60 to 75 degrees west; Second Mountain and Rook Mountain southwest and 15 to 65 degrees west. p. 228. "The stones and boulders are in many cases from distant localities," those containing fossils are found in place only on the northwest side of Kittatinny Mountain. 229. "Two skulls of the walrus, an animal living only in the polar seas, have been found in the gravel near Long Branch." p. 342. These were, no doubt, ice borne; the question is whether by floating or creeping ice? Parts of South Carolina has undergone a similar denudation of one hundred and fifty feet. Tuomey's Gel. Rept. 102. All these are evidences of the doings of ice, and of currents of water from the northward, and not of the rigid movement, and grinding, leveling power of a gigantic ice-sheet.

British America, north of and including Canada, is generally a plane; its lakes being from three hundred to eight hundred feet in height; and the chain of great lakes bounding the United States are from two hundred and thirty-two to six hundred feet, the height of Lake Superior; so that the rise between Quebec and the west end of that lake, twelve hundred miles, averages six inches a mile. Survey of Canada, 1863, p. 6, 7. A table of one hundred and forty-five glacial grooves is given in the Survey of Canada, with a general southern direction, p. 890, of which eighty-four range west of south, some of them from 45 to 76 degrees, and fifty-seven range eastward, some of them from 45 to 80 degrees, or approaching an east and west direction. These are in Southern Canada, below 50°36′ of north latitude. Along the Ottawa the furrows conform in a general way to the direction of the river valleys, the limits of which appear to have guided the moving masses producing the present grooves." Ib. 889.

The superficial deposits in the vicinity of Montreal show former sea margins at the heights of 470, 440, 386, and 220 feet over the sea level. Dr. Dawson, Geol. Report of 1863, p. 918. Below the lowest level and about one hundred feet above the St. Lawrence, or one hundred and twenty above the sea, are the stratified deposits of gravel and fine-grained sand; then comes a calcareous gray sand, which rests upon the boulder clay, which is filled with rounded and striated fragments of various rocks, all of the thickness of about one hundred feet, of which the boulder formation is the greater part. The rocks beneath are polished and grooved. The boulders were drifted southwestward, and came from 40° to 70° east of north. Ib. —. Yet, towards the mouth of the St. Lawrence, a Gaspé boulder of limestone, 40 feet in diameter, has been moved several miles north or northeastward, and blocks of granite from Table-topped Mountain down Magdalen Valley several miles northeastward. Dr. Dawson described similar instances of northward transportation of boulders in Nova Scotia. Ib. 803. The White Mountains were at long distance of time twice elevated, first by a force from north 80° west, then from south 10° east, which indicates the thrusts of oceanic depressions from the west as well as from the Atlantic. See C. H. Hitchcock's Rep. to N. Ham. Leg. for 1871, p. 9. It is thus seen that Canada as well as New England and the Mississippi

Digitized by Google

Valley rose from the ocean, and at different elevations the abraiding ice had different directions.

By the Ohio Geol. Survey, vol. i, p. 538, it appears that of the striæ across the islands in the west end of Lake Erie and in the Maumee Valley, sixteen observations in eight counties, have a bearing south 80° west to 35° west with two intersecting grooves south 15° west. At West Sister Island the glacier moves westward, the pressure and planing being greatest at the east front, while on the opposite shore the undulating surface of the rock has been merely scratched. p. 539. The limestone rocks of that island contained imbedded flint nodules, which offered a greater resistance to the ice. On the "lee" side of each is a long ridge in the limestone by reason of the protection of the hard flint. This phenomenon, says Mr. Gilbert, "seems to afford a better explanation of the long, smooth, even furrows so frequently seen, than the theory that they have been engraved or ploughed by large boulders;" p. 540; that is to say, the rocks were ground by the ice.

Dr. Newberry describes the drift deposits of Ohio, and as to the lowest says, the "sheet of clay and boulders I have termed the Glacial Drift because it seems to be the direct product of glacial action." p. 86. Scattered over the drifts are numerous boulders, often of great size. They must have "been floated to and dropped upon their present resting places. In my judgment no other agent than *floating ice* could have accomplished their transport in the manner in which it has been done. Hence, I have considered them as the result of iceberg action, and have termed them and the northern gravel with which they are associated, the *Iceberg Drift*." 87, 183; 2 vol. 4.

Pursuing the Ohio Survey into the second volume of 1874, Dr. J. S. Newberry gives many pertinent observations and reflections: "In Ohio we have no geological formations intervening between the Carboniferous and the Quaternary." The reason, "about the close of the Carboniferous Age the Allegheny Mountains were raised, carrying up all the area lying between the Mississippi and the Atlantic. From that time to the Quaternary no part of this region, with the exception of the southern margin, was ever submerged." "West of the Mississippi the land has been often and long below the ocean level since the epoch of the coal measures." "The materials which accumulated during the Quaternary are beds of clay, sand, gravel, and boulders, which have received the name of *Drift*." "The drift deposits cover nearly all parts of the State." p. 1. He holds that the rocks were planed down to latitude 40 by glacial action. p. 2. The lowest drift deposit, "though not always present, is a tough, blue, unstratified clay, generally thickly set with small stones; more rarely containing those of larger size, ground and scratched;" hence, called the boulder clay. "In certain localities the pebbly 'hard-pan;' or boulder clay, is overlaid by a greater or less thickness of fine laminated clay, without pebbles;" and these blend so as to leave no line of demarcation, and together are called *Erie clay*. Above is the *Forest Bed*. p. 3. "In Western Ohio, In-

Digitized by Google

diana, Illinois, &c., the uppermost strata of the drift is called the Loess or Bluff formation." These "are the products of the last submergence, and I have termed them the *Lacustrine* Drift." Upon these "are scattered boulders and blocks of all sizes of granite, greenstone, silicious and mica slates, &c., &c., &c., generally traceable to some locality in the Eozoic area north of the lakes." "The boulders are found on nearly all the drift-covered area of the State; being carried over the summit of the water-shed, and reaching south nearly or quite to the Ohio. The margin of the boulder area seems to mark the outline of the great ice-sheet at the period of its greatest development; but *most of the boulders* strewed over this area, *appear to have been deposited by another agency,* at a much later date." They lie near the surface, often over purely laminated clay, "and hence could never have reached their present positions through the agency of glaciers or powerful currents of water. They must, therefore, have been *floated* to their present resting places. The evidence is conclusive that they were transported by icebergs, and hence I have called them the *Iceberg Drift.*" p. 4.

Dr. Newberry gives 87 observations of a system of grooves confined to the lake basin and the northwestern counties of the State, from which he says "the prevailing direction of the stria is 10° south of west," and remarks "that in this portion of the State a series of glacial marks which have a nearly north and south bearing, are obliterated by the stronger, fresher, and more numerous grooves of which the bearing is nearly east and west. As I have shown elsewhere, the striæ which cover the highlands and southern portions of the State were probably made by the continental glacier which existed during the period of greatest cold, and which had in Ohio a movement from north toward south and southeast; while the glacier which moved from east westward in the lake basin was a *local glacier of later date,* and the one by which the excavation of the lake basin was principally effected." 2 Ohio, R. 10.

"It seems that in the period of greatest submergence the larger part of the summit of the water-shed was under water." "At this time a sufficient depth of water existed in the passes of the water-shed to float icebergs of considerable size, and as currents flowed through these passes, some of the boulders scattered over Southern Ohio were probably transported by them." Five of these passes are noticed; marked "by deeply excavated channels, now more or less perfectly by great accumulations of rolled and transported material, such as would be the natural product of a copious flow of water, continued through ages of time, and gradually diminishing and losing its transporting power." p. 47. These out-lets carried the waters southwestward into the seas or lakes of the great Mississippi valley. The Niagara River and Falls then were not. p. 52.

"The boulders belong almost without exception to the chrystaline and igneous rocks that are found *in situ* only to the north of the great lakes." p. 26. None are from east Canada or Labrador; but nearly all "can be traced to places of origin in localities north and northwest of Ohio." p. 27.

Digitized by Google

An inquiry here arises that if floating ice must have been the cause of all the drift and erratics, why should not the same cause have produced the boulder clay? The floating ice could as well do it, as it ground over the ledges of rocks, as an Arctic glacier and the water could better spread the clay as it is found. Such a supposition would obviate a resort to the great ice-sheet for explanation, and avoid other difficulties to be noticed. It is certainly an immense conception of an abnormal cause to explain a limited effect, that seems to have already had its sufficient and acknowledged solution in the cause of every other stratum of the drift.

It is said by Dr. Newberry (2 Ohio Rep. 29), "That the boulder clay was not deposited *beneath* the glacier, as sometimes stated, is apparent from the fact that it covers the glaciated surface on which the ice rested, in a sheet sometimes a hundred feet in thickness. *It must, therefore, have accumulated at the margin of the glacier.*" As the boulder clay is very widely spread, as well as often of a great depth, the more natural inference would seem to be that it was spread by the waters, as ground from the rocks by floating ice-rafts, and afterwards yet more dispersed by the ocean currents. But the witnesses do not always agree with themselves or with each other upon this subject.

The 2 Volume of Ohio Rep. in its Chapter L., contains views at variance with the theory of "the glacier," contributed by Mr. E. B. Andrews. He says Professor Hopkins expresses the belief that the boulders found on highlands of the 2d Geological district, were transported by floating ice-rafts, "and not by a vast, continuous northern glacier," and that drift materials were carried down to the lower Mississippi district. And Professor Hilgard thinks that "the phenomena observed in the Southern States are but the necessary consequences and complements of the drift phenomena of the North," and says it is time "that the Ohio should cease to be proclaimed as the southern limit of the drift." p. 451. Mr. Andrews speaking of the southeastern part of Ohio says, we have seen "there is no evidence that the pre-glacial or ante-drift surface *was essentially different from what it now is*. If there was a climate so arctic in character as to allow of the extension of a sheet of ice immensely thick almost to the Ohio River, we should expect that the same cold climate would necessitate glaciation in the Allegheny Mountains, but a short distance south of the Ohio, where no traces of glaciers have been found. The average altitude of the Allegheny range is 3,000 feet. If, on the other hand, the cold were produced by marine currents coming down from the Arctic region, it would have the sharp limitations characteristic of such currents at the present day." "Local glaciers are freely admitted to have existed on the higher grounds adjacent to the icy northern currents." p. 449. Mr. Andrews quotes the strong views of the Duke of Argyle, President of the Geological Society of London, against the glacial sheet, as satisfactory. p. 450.

In the Geological Survey of Illinois, of 1873, the northwestern section is described by James Shaw. He says, "That vast glaciers of ice once extended over large portions of North America is now universally conceded.

Digitized by Google

Their slow, crawling motion and irresistible force ground the rocks to powder, as wheat is ground to flour between the upper and nether mill-stones; not only ground them to powder, but rounded and polished the boulders and the gravel, planed and grooved the rocky surface of the earth, and moved the vast masses of drift materials from place to place in slow procession." 5–6. "But the great mixing and transporting agency which arranged, assorted, and deposited our Northern Illinois drift deposit, was evidently *the mixed action of ice and water.*" 6. The first and greatest force was the glaciers of the high lands; "then the floating iceberg and ice-field produced by their results, carrying the large boulders from place to place, and dropping them over the ice-cold seas; and last, the wave and current forces of water, after the ice had in part, or altogether melted, left loose clays, sands and subsoils, substantially as we find them now." 6–7. "Eroding and denuding influences have removed from three hundred to three hundred and fifty feet of Magnesian limestone and shales." "The dynamical powers of heavy bodies of water and water currents, and other drift forces, must have acted long and powerfully in bringing them about." 31, and see 32. "A mixed mass of gravel * * would seem to indicate that forces from a distance and forces near at hand, operating in every conceivable direction, with great force and over long periods of time, all contributed to gather together these heaps of abraided materials, some from the distant regions of the granite and the traps, and some from the neighboring limestones of a bygone geological age; but all equally worn smooth by the grinding of the waters and ice." 109. "Whether the floating iceberg, or the slow crawling glacier, or the strong water currents, or all these combined, transported the coarser materials of the drift, the force of the powerful agents were much modified in their action here." 145. It would seem that the other powerful causes stated, might suffice, if "the slow crawling glacier were omitted; and this is the opinion of Mr. E. B. Andrews; assistant in the Ohio Survey, 2 Vol. 447. He says, "There is no general planing off of the rocks; but everywhere among the hills where the northern boulders are most abundant are projecting knobs or outliers of soft rocks, which would naturally be an easy prey to such a destructive force as would be exerted by the movement of a vast glacier." 448.

Moving westward we reach Wisconsin, Iowa and Minnesota, upon which David Dale Owen made his Geological Report, to the U. S. Government in 1852. Among the materials of the drift the "trappean rocks are much the most common." "They originated at the time of the upheaval of the trap, and at comparatively a recent period. There are facts ascertained which render it probable that a large area of the Northwest Territory has been raised during very modern periods, even since the present fauna inhabited its rivers and lakes." "There is a gradual drainage of its waters taking place, even at this time." p. 143.

"In the vast prairie region of Iowa, the attention of the geologist is frequently arrested by erratic blocks of enormous dimensions, scattered here and there, and half sunk in the ground." "They are far from their

Digitized by Google

original situation." "The only explanation that is at all satisfactory in accounting for the transporting power which has brought detached masses of granite rocks into their present position, *is floating ice*; ice drifted by currents setting from the north, before the land emerged from the ocean, in the same manner as, at the present time, thousands of tons of rocks are precipitated on the bed of the Atlantic Ocean from icebergs." "Their isolated position in the prairie also indicates that they were dropped into their present positions rather than rolled into it." 144, 145. "The clay-beds are often thinly laminated, at some exposures, the laminæ are wrinkled. They conform in their dip to the general undulations of the country." p. 298. This, of course was after the depositions.

Charles A. White's first annual Report in 1867, to the Iowa Legislature, speaks of meeting with some striæ on the bluffs which border the bottom lands of the Missouri River; the coarser set (No. 1), S. 20° E.; the finer (No. 2) S. 51° E. Set 3 below Omaha is S. 41° W. p. 144. The direction of the scratches No. 3 observed coincides pretty nearly with general direction of the western watershed of the State; "and sets No. 1 and 2 respectively represents currents approximately coinciding with the general courses of the Missouri and Platte Rivers." p. 145. Diversity in the direction of the grooves, passing from all northerly to all southerly points, and in conformity with the trend of valleys and water-sheds, favor the theory of the cause being floating ice rather than the rigid gigantic ice-sheet that would hold its course onward against all obstructions, according to the glacial theory.

Professor Hayden has occasionally noticed the action of ice during his recent explorations in the far west, but the striations have been mostly from the valley glaciers in the mountains. He says: "Along the Platte River, below Omaha, and on the Missouri, near the city, the carboniferous limestones have had their upper surface so thoroughly smoothed by glacial action that they can be quarried out and used for caps and sills without any further finish of them." Report for 1870, p. 99. "There are a few small grooves or scratches, and * * I ascertained their direction to be about 27° west of north." All the limestones round Omaha, under the yellow marl and pebble deposits, were so smoothed. "In the mountains proper, the evidences of glacial action are not uncommon, especially on the sides of the deep valleys and gorges, but the causes were local and operated when the temperature of the climate was much lower than it is at present." p. 100.

Speaking of the eastern portion of the Rocky Mountains, source of the Arkansas, Professor Hayden says: "Perhaps the most interesting and novel features of this region are the great morainal deposits, the remains of ancient glaciers. These proofs of glacial action occur everywhere along both the east and west sides of the great Sawatch or Mother Range. But up the valleys of some of the side streams the morainal deposits are more marked and regular than in others." Report for 1873. Speaking of the Park Range, the gentle slopes are on the east side, the west sides very

Digitized by Google

abrupt, sometimes the rocks overhanging indicating that they are a portion of an anticlinal. Ib. 39. So our Appalachians and Atlantic seaboard hills lean from the Atlantic Synclinal, as if the upheaving force was in the sinking bed of that ocean, or as one preponderated in the balance the other rose.

One other great feature of structural geology is to be noticed in these Reports. The mountains are built of granite, gneiss, &c. From the Mississippi and Missouri to the Rocky Mountains the stratified deposits of sandstones, limestones, shales, slates, and clays, lie in flat broad sheets, "much as they were when first laid down, one after another in the *bottom of the vast ocean which once existed here.* Since this ocean was gradually drained off, the ceaseless action of the rains and rivers has in places removed thousands of feet of these rocks, exposing beds which were once deeply buried, and in which we can occasionally find the remains of shell-covered beings which still earlier lived and died upon the ocean bottom, or of the skeletons of the animals and plants which peopled the surrounding shores, and were swept by the ancient rivers out into the sea to be buried with the then forming sediments." Dr. Hayden's Report for 1873, p. 93.

And Dr. Newberry, in the United States Report for 1870, says of the lakes that once occupied the region immediately east of the Rocky Mountains: "The sediments that accumulated in the bottoms of these old lakes show that in the earliest periods of their history they contained salt water, at least the sea had access to them, and their waters were more or less impregnated with salt, so as to be inhabited by oysters and other marine or estuary mollusks. "In due time the continental elevation which brought all the country west of the Mississippi up out of the wide-spread cretaceous sea, raised these lake basins altogether above the sea level, and surrounded them with a broad expanse of dry land." p. 329.

But how came such "continental elevation?" Not alone by lifting up the continent bodily, else would the marine deposits have remained at the top and the waters have been drained off, carrying off largely its deposits; but must have been largely raised up by the degradation of higher lands or mountains by freezing, thawing, and erosions, and the flow of the materials into the basin of such sea and lakes, thus preserving both the salt and the fresh water fossils found there in "wonderful" abundance. So were Ohio, Indiana, and Illinois, filled and raised up, and hence, old river bottoms are found far beneath the present surface. And the stratified rocks thus formed have been since cut down into cañons, and even the granites also; all disintegrated both by frosts, heats, and erosive waters, and ice, as well as chiseled by "sand blasts." Hence are there many rocks left perched in the west as in the east, that have never been lifted, or floated by ice, but have simply held their positions after the surrounding strata had been carried away by the above named dynamic causes.

Dr. Newberry further testifies that, "In the progress of the Cretaceous Age, the greater part of the continent west of the Mississippi sank beneath the ocean, and the deposits made during the later portions of the Cretaceous

Digitized by Google

Age, contain a vegetation more tropical in character than that which preceded it. It seems probable that at this time the lands which existed as such at the west of the Mississippi, were islands of limited extent, washed by the Gulf Stream, which apparently had a course north and west from the Gulf of Mexico to the Arctic Sea." Prof. Hayden's Geological Survey of Wyoming, &c., for 1870, p. 336. It will not be forgotten that the tropical vegetation spoken of, was due to the warmth of the Gulf waters flowing to the northwestward, and perhaps, the Earth's interior heat, yet unradiated.

As by the discrimination made in the west by which all the drift above the boulder clay is ascribed to *floating ice*, so by the same rule the sand and boulders of New England should be ascribed to the same cause. They should be regarded as water-rolled and water-borne in ice rafts as they appear to have been, when existing mountains there were at different heights, and where the lower ridges were not so high nor the valleys so deep as now, and all but the highest mountains were under water, so that the excoriations would be the more continuous, and the rocks lifted from one ridge be carried upon another or dropped intermediately ; reaching Long Island and the sea, or let fall at Stonington, or in the Sound and bays. Thus they might have been carried to ridges now higher, without violating the law of gravitation, as the latter may have risen disproportionately, as did the White Mountains compared with the Green. In Ohio, Indiana, and Illinois, they had not such mountains to guage the rise of the land as in New England, by the water level, as shown by the grooves of transported ice, but the water at the west left the proofs that it was the agent that shaped the surface of the country more perfectly than the ice-sheet would have done. Dr. Newberry speaking of the five gorges in Ohio, that gave outlets to the water towards the southwest, says: "Each of these gorges is now more or less filled with drift, but the remarkable similarity of level which they present will strike the most casual observer, and will not fail to suggest their reference to *a common producing cause*. All the lines of drainage leading southward from these passes are marked by deeply excavated channels, now more or less perfectly filled by great accumulations of *rolled and transported material*, such as would be the natural product of a copious flow of water continued through ages of time, and gradually diminishing and losing its transporting power." 2 Ohio Rep. p. 47.

Dr. Newberry speaks of repeated vertical oscillations of the surface: says, "The withdrawal of the water of the last submergence of the drift took place slowly, and its progress was marked by periods of rest, and perhaps, of recession ;" hence, the *Terrace Epoch*. Ib. 50. The ice period was one of an elevation of several hundred feet. It was followed by a water period and warmth ; the continent five hundred feet below the water level. The first deposit of this period was the boulder clay. p. 6. This would seem to make it a deposit under water. Then came the laminated clays, on this came the forest and peat beds, which of course grew in the air. After these may have grown for hundreds or thousands of years, a submergence

Digitized by Google

of the continent took place. During this, the *clays, sand, and gravel were deposited; floated down by icebergs from the Canadian highlands,* with blocks of granite, greenstone, slates. See p. 7. Yet "the glacier" is credited with having carried large blocks of lime and sandstones "one hundred miles or more southwest to points several hundred feet above their place of origin," from the north or islands within Lake Erie. p. 29. In view of all the circumstances it would seem more natural to infer that these large stones were transported by floating ice-rafts and deposited on ground that was *afterwards elevated*, as it often was by an interior force.

Again, Dr. Newberry says: "At the commencement of this ice period this continent must have stood several hundred feet higher than now." 2 Ohio Geo. Rep. 6. That the first product in Ohio of the ice period, was the boulder clay. And that in New England and other countries where granite and other silicious matamorphic rocks abound, the product of glacial erosion is sand, gravel, and boulders. As the great ice sheet retreated northward it thrust out and left behind it a succession of heaps of boulder clay which now form a nearly continuous sheet over the glaciated surface," Ib. These quotations present some difficulties. If the continent was several hundred feet higher at the commencement of the ice period than now, so much greater would have been the difficulty for ice to come hither from the Pole by land; whereas if it was then under water, as under the next coming drift period, such a rise was unnecessary to account for the Till which might be the product of floating ice; that would also dispense with Mr. Winchell's mountain at the Pole to make an incline for the ice to come down by gravity. And, again, it is not perceived how a northwardly retreating ice-sheet, that is, retreating only because and as it melted, could have *thrust out* and left behind it the boulder clay, bearing all the evidences of having been spread out and deposited under the action of pervasive waters. Indeed, Dr. Newberry seems to have raised the continent once oftener than necessary, if the boulder clay could have been deposited under the sea as he admits the drift and many boulders were.

Now, seeing from all the testimony cited, that Canada and all directly to the north, was under the ocean; New England also, except the highest tops of the mountains; and the great Mississippi Valley was also an extension of the Gulf of Mexico; that there were no great Mountains northwards of Canada, nor in Canada, but an ocean current bore thence southward dividing southeastward over New England, and westward and southwestward over the country lying between the Rocky Mountains and the Alleghanies, what is so likely to have been the source of the Till, the boulders, the drift, and rock groovings as the northern ice borne upon the northern oceanic currents? There may have been icebergs broken from Arctic Mountain glaciers, and other ice formations; all floating as ice rafts, thick and of irresistible momentum, grinding upon ridges yet under water and carrying their materials southward.

In view of the preceding facts it seems sufficing to say, that when New England, the Hudson and Champlain Valleys, Canada and the British

Digitized by Google

Possessions, Ohio and states west and southwestward were under water, and the currents and ices of the Artic Ocean had full sweep over those areas, we have the conditions to account for all the phenomena witnessed. without resorting to the extremely abnormal cause of a continental ice-sheet. The depression of New England Professor Winchell speaks of in this wise: "The higher summits only held their heads above the careering waves: deposits, bearing the marks of oceanic action reach to an elevation of six thousand feet on Mount Washington, two thousand or more on the Green Mountains, and three thousand on Monadnock." p. 229. If these measurements had the same sea-datum then their differences record the differences of the mountain depressions, or rather the elevations they had then attained. The same height on Mount Washington is that given by Agassiz as the highest elevation of the ice excoriation; Journey, 425; and that being the greatest ocean height, the conclusion is clear, that it was the edge of ice-sheets that made them, and these could only be floating ice; certainly not stones in the bottom of a continental ice sheet. The inference must further be that as the sea thus registered the greatest depression, or want of elevation of *each* mountain, Mount Washington had been four thousand feet lower than the Green Mountains, and three thousand feet lower than Monadnock; so that there was such depth of water over the valleys and plains as that the Arctic Sea could flow over them, floating either ice-bergs, or belt, or surface rafts of ice. The land it was that was unstable, while the sea kept its level. The supposed gigantic ice sheet needed not to be fifteen or ten thousand feet, or so many hundred feet in thickness, to make those mountain grooves, when the mountains stooped nearly to the level of the sea, or their tops had but peered above the water. All were not equally low, otherwise the highest grooves in all would have had the same level. And so a continental ice-sheet moving on the land already elevated should have scored them at nearly the same level; in either way showing that the mountains had not been sunk equally, or that they had risen unequally. The submergence of New England, with an open interior sea to the pole certainly shows an easier way of accounting for the ice grooves upon the mountains, than to raise a land mountain at the north pole, and an ice-mountain upon the top of that, with a refrigeration to keep the sheet of the thickness of ten to fifteen thousand feet in the "Granite State."

While there are the ice grooves of New England and elsewhere to be accounted for; and these sharply cut, and geologically recent, there seem to be other things visible on the surface quite incompatible with the supposition of a continental glacier of the thickness imagined. The hills of New England, under such a power should have been more leveled down; for a glacier kept hardly frozen could not have much viscosity; it should have crushed the stones into the *moraine profonde*; should have carried few angular erratics, for the mountains to furnish them would be "few and far between," with comparative small elevation. But what do we see there? Huge boulders; rocking boulders; perched up rocks, that would not have been there after such a planing with the gigantic polar-ice plane; and a

Digitized by Google

surface covered with water-rounded stones of every size and kind, which had to be gathered into stone fences before the soil could be reached for cultivation ; yet so rounded are they that they readily roll out of place, though the base of the enclosure be broad. These are the natural product of a water-covered surface ; of waters floating ice ; which ice may have been thick as Greenland hummocks' ice-belt ice, or glacial icebergs, borne on the arctic current that now comes southward along the eastern side of our continent. We see the evidences that as the ocean retired, the elevation made successively of every part of New England a sea-lashed shore, leaving the drifts that the waters had spread over the sea bottom.

The glacialists seizing upon the one seemingly sufficing adequate cause of a great ice sheet, overlook the difficulties which that theory must encounter to account for that cause, and also other means that may more naturally account for the seen results, without resorting to any abnormal freak or eccentricity of Nature. They may notice that the grooves very generally conform to the trend of the high valleys and water-sheds and to the course of the currents when wide areas were beneath the sea ; denoting the descent of mountain glaciers, or the transportation by water of ice-rafts, or icebergs. They refer not to the transporting power of water in times of ice-floods, when mountain sides slid down, and lakes broke through their moraine dams. They take the presence of irregular boulders in the under clay of the drift as the sure evidence of the work of the polar ice-sheet, while the presence of the like boulders in all the drift, as we see here in Philadelphia, is not taken as proof that all the other strata of the drift had the like cause. The heavy boulders they see at a higher level than their parent place *in situ*, they suppose could only reach their elevations by being pushed up by the great continental ice-sheet because it must obey the pressure of the great ice-head at the pole, and approximating the level of that source of pressure, rises over the secondary mountains of New Hampshire, the Katahdin of Maine, and bridging sounds and inlets of the seas passes into the Atlantic. It is overlooked that those boulders may rest on elevations that may have risen out of the sea from a lower level than the parent quarry ; or may have been shoved higher by the back currents of water that will drive ice-sheets high upon each other when they encounter obstruction ; while on the other hand the ledges of rock that yielded the supply may have sunk lower, by the earth's oscillations, or have been ground down by floating ice, after higher rocks had been carried away.

It is said the glacial epoch was so recent that the mountains were already so degraded as to be near their present height when that epoch come on, and could not have been cause of the effects seen. Now the last glacial epoch is placed many thousand years ago ; Geikie says more than two hundred thousand years. We will not hold him to exact figures; but take it that was near the time, then it appears to have been ample for the mountains to become reduced from a much higher elevation than their present size, by the operation of normal causes, but anciently acting with greater activity. Now in every year since they rose the height of the

Digitized by Google

Alps has been lowered by causes that have never for one moment ceased; and yet more rapidly have the glaciers. which never ceased to flow, worn more deeply their channels. The striæ made by the ice on the sides of Monte Rosa and the Bernese Alps show that the glaciers moved at higher elevations relatively to the scored rocks, and adhering to the causes named, we must conclude that the mountains were higher and broader to increase the supply of snow, and that the glaciers moved upon a higher plane, whereby they scored higher tracings on the rocks, and projected further into the valleys below, and carried their boulders to a greater distance. These are causes sufficing for the visible effects, when we add to them to the transporting power of ice-bearing floods, carrying down land slides, and ice-covered lakes, which burst the dams that had sustained them. We need not go to the north pole or the planets to explain the phenomena of the Alps; except as icebergs floating down from the north would bring an arctic cold with them.

Lyell says "the Alps have acquired four thousand, and even in some places more than ten thousand feet of their present altitude since the commencement of the Eocene period." 1 Prin. 256. He speaks of what they *retain*; but what height they had at their greatest exaltation no one can tell, for upheaving elevation and disintegrating degradation are generally simultaneous proceedings; but from facts observed it seems more reasonable to infer that great glaciations were mainly local, except as arctic currents came down upon Central Europe freighted with ice.

Dr. Hector's statements lately made before the Geological Society in London, have a bearing upon several points of this discourse. The South Island of New Zealand has its Southern Alps of which Mount Cook, fourteen thousand feet high, is the highest, with a snow-field of one hundred and sixty square miles, in south latitude, nearly 44°. Judging by the moraine matter, snow formerly was vastly more abundant. He "demonstrated the excessive action of glaciers in cutting back cols; an action more energetic formerly; some of the cols having been worn down as low as eighteen hundred feet." "The reason for this contraction of the ice area is the great question for determination. Was it due to difference of climate, the result of a great glacial period? The remains of a past fauna afford no evidence of this. We may, indeed, suppose that the whole fauna migrated to the north; but we must, in that case *invent* the land and bring into play oscillations more extensive than those required for another alternative, viz:—the alteration of level, within the area itself. We might suppose a general alteration of level, even to the extent of four thousand feet higher than the present, but the evidence afforded by the shore line is unfavorable to this view. There remains the theory of *unequal elevation*, which combined with a most enormous destruction, the result of ages of glacier action, best explains the phenomenon." "In conclusion, the author stated his belief that there has been no general change of climate, but many changes of *relative level*, resulting in a great destruction of surface, which had taken place in groups of peaks at *different times*." Nature, January 27th 1876, p.

Digitized by Google

259. This statement is refreshing for its moderation and good sense. The isolation circumscribed the phenomena and forbade extraneous speculations.

Yet it is believed, that if we do look into general causes, and consider them well, we shall find that the forces of nature are so well balanced, that the imagined continental polar-ice sheet must be regarded as an impossibility; shall find that we need not raise mountains at the poles, against the effect of the force of the Earth's rotation, to slide down the ice; nor to submerge mountains and continents once elevated from the sea, again and again, to account for marine remains, or ice scratches upon the rocks, left there as they first emerged from the waters.

The theory of a north polar ice cap, spreading as a garment to the tropics, or to the fortieth degree of latitude only, seems not to have sufficiently considered the nature of the Arctic ice and climate. I open Dr. Kane's second Grinnell Expedition, and find that it wintered in Smith's Straits, latitude 78½°. In January the thermometer ranged from 64° to 75° below zero, Vol. 1, p. 154; from March 10th to 14th, the average was 46½° below zero. "The intense cold approximates all ice to granite." Vol. I, p. 184. Look at the pictures; the ice is as hard and sharp of outline as unworn rocks. p. 162. The glacier that has shed its iceberg presents a vertical front; The ice-belt between the "floe" and the land, is "24 feet in thickness, 65 in mean width; the second, or appended ice 38 feet wide; and the third 34 feet. All three are ridges of immense ice-tables, serried like the granite blocks of a rampart, and investing the rocks with a triple circumvallation." Ib. p. 162.

Dr. Newberry, 2 Ohio Rep. 70, cites Dr. Kane's account of a sheet of ice, eight feet thick, resting on supports twenty feet apart, as having swagged five feet midway of the supports, while the weather was far below freezing point, to prove that the polar ice sheet could flow southward. To one not wedded to that glacial theory the evidence does not seem so strong. With the weight of its own bulk on the centre of a span of twenty feet, we might believe there was a perpendicular pressure much more than proportionable to the force that propels the Alpine glacier. Yet in several months the strain caused no fracture of the ice; no fluxion of particles to change its form; but all except the bend remained of the some shape, and sharp of outline. If it had rested on a plane of the inclination of the bed of the Alpine glacier, there is no indication that its mass or particles would have moved a hair's breadth. It will here not be forgotten that a polar ice-sheet to be thousands of feet thick in New England must be of growing thickness all the way to the pole, and that the intensity of cold for all that distance must have been greater than any Arctic cold known to us, and have held the ice formed in the water as firm as granite, and impervious to any heat that could reach it.

As to the snow that should fall upon land at a period of intense and long continued cold as supposed, it would not form into ice, or make the theoretical continental glacier. To make the ice of the moving glacier, there must be a back pressure from a greater elevation, and an *alternation of heat*

Digitized by Google

and cold; a thawing and regelation; so that climate may be too cold to make glaciers. Thus in Upper Thibet, on the north side of the Himalayas, the mean limit of perpetual snow is not only higher by more than a thousand feet than on the south side, but the belt of snow is narrower, the back pressure is less, and the snow deposited from the dry winds of Northern and Middle Asia are so dry as to make it questionable whether there are any proper glaciers, or anything more than the *névé*, or dry masses of snow in in layers. Reclus, 165–6; Professor Vogel, in Nature, March 16th, 1876, p. 394. Yet the snow there is seventeen thousand to nineteen thousand feet high, with a northern aspect.

Tyndall shews that ice is not viscous; will not stretch, but is brittle and will break under a strain, as when the glacier is compressed into a narrower channel; or must make a descent or curve; when the continuity is kept up by a back *pressure* and regelation; freezing then becoming an agency in wedging forward the mass in its shearing and descent. (Hours of Exercise on the Alps, 356, &c.) Yet under *pressure* it conforms to the valley and descends as if it were plastic. Ib. 358, 359, 401. To consider the difference between Tyndall and James D. Forbes, who held the theory of viscosity, is not now material. They both were dealing with the glacier in its cradle on the side of the Alps, having an inclination of four to five degrees, with a heavy incumbent pressure of the higher glacier, having a length of twenty or thirty miles, a width from two or three miles where widest; in one instance contracting from two thousand to 900 yards, with a depth sometimes of six hundred feet. Yet the downward flow was so slow as to require nice instrumental means to detect it, and though variable, owing to the difference of inclination, or choking of gorges, the figures for the day of twenty-four hours, most usually found are from twelve to twenty inches. 1 Lyell, 365, 366, 367. The flow is slower in winter than summer, and faster at the centre than the sides, and at the top than at the bottom.

It is apparent that the circumstances are not parallel with the supposed ice-cap at the North Pole. The existing testimony is, that this is an open sea; and if not that, is an ice covered sea, without land. There is not even level lowland for the ice to form upon. There is no mountain to bring the force of gravitation into operation. The ice that could saddle the pole could have no tendency to move in any direction, for there is no inclined plane. The hard frozen ice would not be borne downward by the weight of higher ice; nor crevices be filled by regelation, thus to wedge forward the frozen mass, as in high mountain regions. Greenland is a ridge of three thousand to four thousand feet elevation, and that will make glaciers in the valleys. But the supply of ice thence, or from Grinnell Land, or Labrador, to reach Europe, must have been *floating* masses; and so as to the interior of our country, if they came so far.

Ice is, in another respect, less likely to descend by land to a lower latitude from the pole, than if resting on a solid plane. Though the ice at a very low temperature would not melt in the air, yet, *resting on the water* it would become *sodden*, rot and sink; and without land support could not

Digitized by Google

rise to a height to spread the mass outward by its *own* fluidity, or any pressure of impending weight of ice. The point of least resistance would be the sodden ice and water beneath. The fresh ice contains no salt; the "water sodden," is "thoroughly infiltrated with salt-water." 1st Kane's Grinnell Expedition, 96. Captain Richard Wells, commanding the whale Ship Arctic, wrote to Mr. Grinnell, June 18, 1867, that he had steamed up Smith's Sound to about 79° of latitude; found the ice "rotten and very much decayed, the ship steaming easily through rotten floes. The ice on the east side, excepting in Whale Sound, appeared to have decayed away and parted from the land as far as the glass would carry, and would offer no impediment to the progress of any steam whaler. A poor foundation this, upon which to build a mountain of ice.

And consider also the geography of the Arctic region as to the proportion of sea and land, and the interposing elevations of the land. Remember, also, that the earth's features at the supposed glacial period were in outline the same as now. A polar ice-sheet to cover North America and Northern Europe must have filled the ocean to the bottom and risen to a height far above the sea to compel the ice to move by pressure southward to the 39th or 40th degree. We need not estimate what that height must be, when we know it would have no land basis to rest upon; and know also that intermediate mountains, indeed all land, would be obstructive of progress instead of sources of power. In Europe, such a polar ice-sheet must have filled the Arctic Sea, and risen from its bottom over the mountains of Norway, Sweden and Scotland. In North America it must have risen over the mountains of Grinnell Land, that of Greenland, and the Labrador and Laurentian ranges, and crossed the St. Lawrence River. But glaciers under pressure would sooner squeeze through a gorge, as two thousand yards in width will pass through a defile of nine hundred yards in the Alps. The channel of the Atlantic would be preferred to the elevated land to travel southward across fifty degrees of latitude by land. The continental ice-sheet would have been a glacier in the Atlantic. That the north polar sea is open, is not only proved by men who have looked upon it, but Dr. Scorsby testified that the "Right Whale" that always shuns the tropics, has carried the marked harpoon from Baffin's Bay, through Behring's Strait, into the Pacific; and the whale must breathe the air. He could not cross the equator, nor go under ice into the Pacific, Maury's Ph. Geog. of the Sea, Sec. 144. The birds go to the north of Greenland to breed because there they find their food in an open sea; and we know that northwest of this continent the Arctic Ocean extends down to the seventieth degree of latitude.

Again: Concede the extreme glacialists solid land at the pole for the ice-cap to rest upon; yet consider the enormous demand made upon our credulity to meet the conditions of their theory. The ice-sheet is to be from ten to fifteen thousand feet thick in New Hampshire, according to Agassiz: It is to reach the fortieth degree of north latitude according to several other glacialists. To give it the pressure by gravitation of the glaciers

Digitized by Google

of the Alps it must rest upon an inclined plane of four and a half degrees descent; or have such an elevation at the pole in its own thickness as to be equivalent to that inclination; and that would require a height of ice at the pole of two hundred and seventy-one miles, that the sheet might reach the fortieth degree of latitude. The statement of such requisition seems sufficiently condemnatory of the theory.

There are laws of limitations ever ruling all nature, including the powers of the air. These all have their boundaries they may not pass; their effects cannot transcend their limited cause. When we consider and perceive that no glacier or polar ice-sheet can be formed without snow, we must also perceive that the quantity of snow must find a limit in the heat that evaporates the water into the air that shall fall as snow. Create the Arctic climate over the world, that is requisite to maintain the supposed great ice-sheet unmelted, and you cut off the amount of evaporation necessary to form and preserve that ice-sheet. You have thereby made it an impossibility. To diminish the Sun's heat is to cut off the supply of snow to build the great glacier. Tyndall on Heat, 206. "We cannot afford to lose an iota of solar action; we need, if anything more vapour; but we need a condenser so powerful that this vapour, instead of falling in liquid showers to the earth, shall be so far reduced in temperature as to fall in snow." Ib. 207. That condenser must be *the mountains*, or be the polar cold. But the supply of *heat* from the Sun is ever a *constant quantity*. "This expenditure, (of the Sun) has been going on for ages, without our being able, in historic times, to detect the loss." Ib. 434. It is a supply ever dispensed; never spent, never varied; and will not permit the growth of the great ice-sheet. Less heat would make less snow, and snow must make the ice-sheet or glacier.

The theory supposes the ice-sheet to reach below the 40th degree of latitude; and the cold influences of that would extend over the world. There would not only be a failure of evaporation to fall as snow to maintain the ice-sheet; but the snow formed *could never reach the pole*, or approximate it, to form the head and pressure to drive southward the continental glacier The evaporated moisture of the tropics would be precipitated in snow as soon as chilled at the freezing point first reached; that is, as soon, at least, as it reached the ice-sheet. We find such to be the law of snow precipitation on the highest mountains. "According to Tschudi the quantity of snow which falls upon that portion of the Alps which is above 10,-800 feet is comparatively very small. Most of the clouds charged with snow flakes discharge their burden on the mountain slopes at elevations of 7,000 to 8,000 feet." The Earth; by Elisée Reclus, 163. Mountains in Thibet 20,000 feet in height are therefore found denuded of every particle of snow, because the dry winds there have not the moisture to dispense in snow; and for the same reason the north side of the Himalayas have the lower snow line higher than that on their south side, where the heat is greater and the moisture more abundant. Ib. 165–6. Hence also there is an *upper*, as well as a lower snow line on very high mountains. Speaking of

Digitized by Google

Mer de Glace and the Mer d'Aletsch, Reclus says, "It is a very remarkable fact, in regard to both these glaciers, and those of the Himalaya, that the ice-rivers are much longer and more abundant on the southern side of the mountain than on the colder slopes which are turned to the north. This phenomenon must evidently be attributed to the larger quantity of snow brought by the south wind, and impeded in its course by the lofty mountains." Ib. 211–2. Thus the most snow comes from the side where there is the geatest heat for evaporation.

Dr. Hector shows that the same phenomenon takes place in New Zealand as in the Himalaya and other mountains; namely that the snow fall is greatest to the windward, whenever the temperature is at freezing point: "Much of this enormous precipitation is deposited as snow in the Southern Alps, which *comb* out the moisture from the westerly winds; hence the extensive glaciers of the mountain region and the comparative dryness of the Canterbury Plains." Nature, Jan. 27, 1876, p. 259.

As the climate of the world now is, the greatest quantity of snow does not approximate the pole, though it will last longest there. It is more abundant below than above the fiftieth degree of latitude. In British America, above that degree six days of snow in a winter, and a depth of three and a half feet, are normal quantities. 9 New Am. Cy., 327. With an ice-sheet down to 40 degrees of latitude the deepest snow would probably be midway between the equator and pole.

There is, therefore, no cause of the continental polar ice-sheet found in the air; nor is there any effect of it seen under the earth, where the effects should have been often seen, if it proceeded from a planetary cause, for then it should have been of periodical occurrence, and the effect have been seen in fossils in the rocks. Since land first peered above the waters to yield disintegrated material for the deposit of the sedimentary strata, the rocks have kept the registry of every species of plant and animal, and thus recorded the temperature of the globe, and told us that the time was when tropical plants grew on the shores of Greenland. There, on the east coast are the Carboniferous slates and coal, and on the west side of the Island of Disco, at latitude over 69°, are impressions of the rankly growing vegetation of the tropics. The succession of stratified rocks, as arranged by Lyell in his table in their order of deposition, number thirty-eight, 1 vol. 135, commencing at some period of that long "beginning," when the earth was first in preparation for man's inhabitancy. No stratum of all those rocks tells of an ancient glacial period, while they all proclaim that the Earth was a constantly cooling sphere, that it might become fitted for the home of human beings. This process of cooling must have followed that uniformly diminishing rate with which a hotter body radiates its heat into space, with the local exceptions made by mountain elevations, the distances of the poles from the Sun's direct rays and by ice-bearing ocean currents. And certainly the Sun has in no period of the past dispensed less heat to the Earth than now. If there be any fact on, or within the Earth, or without it, to prove the contrary of such inductions from normal causes, it

Digitized by Google

is to be shown, not conjectured, not invented. We are not to be permitted to explain a difficulty by an imagined cause that involves tenfold greater difficulties. This they seem to do who make the induction of a continental polar ice-sheet, such as the glacialists describe it, with the vividness of those who might have seen it. Though their subject be glacial they write with a fervor that betrays an enkindled imagination.

James Croll emphatically invokes an astronomical cause for the Glacial Epochs; but the astronomers have expressed adverse opinions. Humboldt. (4 Cosmos 460) thus quotes Poisson on the Stability of the Planetary system: "It follows from the theorem of Lambert, that the quantity of heat which is conveyed by the Sun to the Earth is the same during the passage from the vernal to the autumnal equinox as in returning from the latter to the former: The much longer time which the Sun takes in the first part of its course, is exactly compensated by its proportionately greater distance, and the quantities of heat which it conveys to the Earth are the same while in the one hemisphere or the other, north or south." Humboldt also quotes Arago on Excentricity: "As the excentricity always has been, and always will be, very small, the influence of the secular variations of the quantity of solar heat received by the Earth upon the mean temperature would appear also to be very limited." If these opinions be true we must look to earthly causes; and not to the Earth's orbital excentricity produced by conjunction of planets in the heavens, or variable heats from the Sun.

There is, however, one cause besides the elevation of the mountains, and the inter-continental influx of the Arctic Sea, whereby the temperature of Northwestern Europe, may at sometime, have been greatly reduced, and that without any cause at variance with the normal physical laws. We have shewn many proofs why there was a central ocean between the widely spreading systems of mountains of the Eastern and Western parts of North America. It may hence have been that the waters heaped up by the Earth's rotary motion, and the trade winds into the Gulf of Mexico, found a passage through that inter-continental sea; and were not, as now, compelled to find their exit by Cape Florida and the Atlantic Ocean, to reach and warm Western Europe. Dr. Dawson did not suggest such a cause for such effect; but said what would truly be the consequence of such cause when he said, "any change that would allow the equatorial current to pursue its course through to the Pacific, or along the great inland valley of North America, would reduce the British seas to a boreal condition." Dawson, 79. The fact shown, the induction is legitimate and inevitable; and seems to be proved by established isothermal lines, shewing how greatly the gulf-stream mitigates climate.

How then are we to account for a past period of glaciation, of whatever intensity, greater than at the present time in certain places. We may do it without invoking abnormal causes. An adequate cause exists within less than five miles of every foot of the surface of the earth. Within that limit, with land elevation to the height of the upper snow line, and breadth to hold an adequate *Mer de Glace*, yet with a sufficient declivity to put the

Digitized by Google

ice in motion by gravitation, we have all the conditions necessary to account for all the glaciation and glaciers of which we find the traces in every country. That the greater glaciers have had such cause seems apparent from their effects remaining where the glacier ice left them. Within reach is ever the producing mountain, or was the open sea to the Arctic. These are sufficing causes for all we see within the range of the causes. The grooves of greater glaciers are seen in parallel lines at great heights on the mountain sides of the glacier-valleys, where glaciers now are, and in thousands of places where they have ceased to be ; and there are the *moraines*, and the rocks *moutonné*, rounded and scored rocks in place, and those transported, all having an exact relation to the moving cause. The Earth by Reclus, Ch. 36. These are the certain proofs that the mountains have been greater, and the evaporation not less, but probably much greater, when the Earth was warmer. For these a continental or polar ice-sheet would in no wise account. It is not needed and is an unfitting explanation of the boulders spread so widely south and east of the Baltic, and even over Scotland, Wales and England ; and such degree of cold may have been so induced by mountain elevations and Arctic sea currents as to invite Arctic animals and plants southward and to drive other animals further south. "It is now beyond all question," says Reclus that the numerous lines of rocks which are found here and there all over Northern Russia have proceeded from the granite mountains of Scandinavia. When an immense sea extended over Finland between the Baltic and the Polar Ocean, the blocks of ice which fell into the water that washed the base of the Scandinavian mountains, drifted away in flotillas towards the southeast to the shores of the continent opposite. The prominent angles of the granite blocks contained in the masses of floating ice have traced out long furrows over all the points and projections of the rocks in Finland, which was then only a marine shoal. M. Nordenskiöld has ascertained that almost all these lines of erosion tend from the northwest to the southeast, and that all the rocks with which the icebergs have come into contact are polished on the side which faces toward Scandinavia, while on the other side they have in every case retained their uneven surfaces, their projections and their clefts. With regard to the boulders themselves, they are all more rounded by friction the more distant they are from the Sweedish mountains of which they once formed a part." Ib. 219. And the same effects are there yet taking place, on a smaller scale.

During the winter of 1862–3, immense masses of ice, coming from Finland, were cast upon the southern coast of the gulf, and thrown upon the land a distance of more than three hundred yards from the shore, and to a height of thirty feet above the level of the sea. The ice which was forty to fifty feet deep, overwhelmed many dwellings and whole forests. In the latter large quantities of stones were subsequently found, which the ice left when it thawed. Reclus, 219, citing Keyserling and Von Baer.

The Danish Professor, Dr. Forchhammer, relates a striking fact to show that large quantities of rocky fragments are annually carried by ice out of

Digitized by Google

the Baltic. In the year 1807 he says, at the time of the bombardment of the British fleet, an English sloop of war, riding at anchor in the roads, at Copenhagen, blew up. In 1844, a trustworthy diver found the space between decks entire, but covered with blocks from six to eight cubic feet in size, some heaped on others; and he found all the sunk ships he visited thus loaded with rocks. 1 Lyell, 382. Now when the Baltic sea was opened to the north pole, and when much of Europe south of the Baltic was below the water level, there was the same condition there as has been shown to have been in North America; namely, an open sea to bear down ice-rafts from the north to supply the drift and boulders that are found spread over both countries, bringing with them a cold atmosphere.

The most recent account of the drift on the eastern side of North Wales, by D. C. Davies, F. G. S., gives us his conclusions: "1. The majority of the deposits are of local origin, being derived from the mountainous regions of North Wales, then an Archipelago of islands. 2. But from the plentiful admixture of foreign matter, he infers *an open sea* on the north. 3. He insists upon the necessity of *aqueous conditions*; the coast would be partly ice-bound, but *there was no general ice-cap*. Besides the general alterations of level there were *local alterations of level*. Proofs of this were to be seen in the neighborhood of Oswestry, beyond which town the Scotch granites do not seem to pass. This the author considered due *to currents* deflecting the *ice-rafts*, &c. Nature, Feb. 17, 1876, p. 318.

Let us be reassured, then, of the safety of Europe and North America, and the world. The Creator, we may believe, did not create the best parts of this Earth and plant there the highest civilizations ever seen upon it, with purpose of its utter destruction. These countries in Europe and America are the hopes of the race, with means of execution, now presented, as they have never been before. There is a uniformity of law, and stability in Nature, that justify man's confidence in the ruling of The Supreme Power, and that He is good. They who most profoundly study His works are the most thoroughly convinced that there is no eccentricity or caprice in His Rule; that He is "The same yesterday, and to-day, and forever." The oscillations of the Earth have become almost infinitessimal; the vertical vibrations as measured by the temple of Jupiter Serapis have not exceeded thirty feet; many volcanoes have been sealed up and people live securely within the rim of former craters; the Valley of the Mississippi will never again be an ocean's bed; the Gulf Stream will continue to mitigage the climate of Europe and preserve its genial temperature; and the Earth continue to turn upon its axis, and to revolve in its orbit, without a tremor; without a moment's loss or gain. God's balance wheel belts this Earth; and He gave to our globe those impulsions in its rotation and orbit which will forever precisely counteract its weight, and maintain its motions with such exactness as will keep all true time forever. Such momentum was given once forever. If not so, then God is forever sustaining His creation.

This earth has never, and upon the certain evidence of Geology, will never suffer a cataclysm. The faults of strata are limited and local; the

Digitized by Google

surface is fashioned by exterior agencies that level, smooth and beautify the world, and fit it for man's use and enjoyment, but which can never mar the sublimity of the cataract, or the majesty of the mountains; many of these crowned with never wasted snows. Some volcanoes yet burn to relieve the earth of the throes of its internal heat and gases, and to tame the earthquakes; yet are the latter sufficing agencies needed to raise the mountains commensurately with the degradations of the disintegrations and erosions of prevailing frosts, heats and rains. None of these, however disturb the general movements of the earth in its orbit, or on its axis, by the slightest vibration, or cause the delay of a second in time in its annual revolution. The Supreme Ruler has taken into the account every cause, and provided against disturbance, in advance; or at every moment keeps all things adjusted to absolute truthfulness. The cooling and shrinkage of the earth's crust, would upon mechanical principle, shorten the radius of the earth's axis, and hasten its rotation, and shorten the day; but as Humbolt says, this is provided against by the celestial movements being adapted to the thermal condition of our planet; and "from the comparison of the secular inequalities of the Moon with the eclipses observed in ancient times, it follows that since the time of Hipparchus, that is, for two thousand years, the length of the day has certainly not diminished by the hundredth part of a second. The decrease of the mean heat of the globe during a period of two thousand years, has not, therefore, taking the extremest limits, diminished as much as $\frac{1}{306}$ of a degree of Fahrenheit." 4 Humboldt's Cosmos, 168.

Some scientific men, and some that may not be truly such, seem fond of writing sensationally, to disparage the creation and to alarm mankind as to the stability and permanence of our planetary home. Andrew Wilson, in giving his travels in "The Abode of Snow," or Himalaya, in the first page of his preface suggests that it is not "an improbable theory that when the accumulation of ice round the south pole has reached a certain point, the balance of the earth must be suddenly destroyed, and this orb shall almost instantaneously turn transversely to its axis, moving the great oceans, and so producing one of those *cyclical catastrophies*, which there is *some reason to believe* have before now interfered with the development and civilization of the human race." One supposes, of course, the traveler to be playfully jocose when he thus speaks to recommend his favorite Himalaya as a safe place of retreat; the Himmels or heavens of our Aryan ancestors; yet Professor Winchell in a work of science is even more sensational, and has several serious chapters upon the inevitable progress of Creation to its ruin; in chapters headed "The Reign of Universal Winter," "The Sun Cooling off," "The Machinery of the Heavens Running Down;" and quotes Helmholtz as saying, "The inexorable laws of mechanics shew that the store of heat in the sun must be finally exhausted." And thus the author of the article "Force," in Chamber's Encyclopedia, gives his views of the finality: "This, then, it appears, is to be the last scene of the great mystery of the universe, chaos and darkness, as 'in the beginning.'"

Digitized by Google

Either then, the universe has been subjected to laws to make waste and decay impossible, and all things that undergo change are preserved in quantity and energy to preserve the whole forever in balance; or there is a Power that ever renews them; for we see that creation does not wax old, but that equal quantities of matter and force remain ever operative without detection of a moment's pause through thousands of years; without the loss of an atom of matter, of force, of heat, or light, without a discord, or tremor in the harmony of the Universe.

Adhering strictly to the Baconian canon of philosophy, to which all philosophers must be held; that is, to proceed only on well ascertained facts, and thence making inductions only in accordance with the laws of nature, also ascertained as facts, it is submitted that it will not be found tnat creation is ever growing weaker, is not verging to decay and annihilation. The more we shall know, the more profoundly we shall consider, the more surely shall we be reassured that this earth is not to perish by ice, or water, or fire; that the force that holds the systems of suns and planets in their rotary movements will never abate; that suns will not burn to cinders, nor their heat and light be spent or extinguished. And by the observance of the same canon of philosophy. of certain ascertainment of facts and strictness of induction, we must also infer from all creation, and creation's laws, that it had an Author to give it law, who wills to conserve it for ever; Him of whom we truthfully say, "Thy law is the Truth:" By, "Thy faithfulness shalt Thou establish the very heavens."

Digitized by Google

AS
36
.A531
v.16

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY.

HELD AT PHILADELPHIA, FOR PROMOTING USEFUL KNOWLEDGE.

VOL. XVI. JUNE TO DECEMBER, 1876. No. 98.

TABLE OF CONTENTS.

Digitized by Google

Stated Meeting, June 16, 1876.

Present, 7 members.

Vice-President, Mr. Fraley, in the Chair.

Letters accepting membership were received from Dr. A. E. Nordenskiold, dated Philadelphia, June 13, 1876, Dr. Juhlin Dannfelt, dated Philadelphia, May 31, 1876, Mr. I. Lothian Bell, dated Philadelphia, June 7, 1876, and Mr. P. Cunliffe Owen, dated 2 Residences, South Kensington Museum, London, May 20, 1876.

A photograph of Dr. I. Lea, of Philadelphia, was received for insertion in the Album.

Receipts for No. 92 Proceedings were received from M. M. Rokitansky & Hyrtl, of Vienna.

A letter of envoy was received from the Royal Bavarian Library, dated March 18, 1876.

Notice of change of residence from St. Petersburg to Jena of M. Böhtlinek was received from Watkins & Co. per Smithsonian Institution.

Donations for the Library were announced from the Academies at Berlin, Munich, Boston, Philadelphia, and San Francisco; the Societies at Leipzig, Ulm, Salem and Boston; the Observatory at Munich; the Library at Munich; the Editors of the Revue Politique, and Nature; the London Geographical, Astronomical, and Zoological Societies; Mr. Edmund Quincy, Prof. O. C. Marsh, Dr. Isaac Lea; Silliman's Journal, American Chemist, Journal of Pharmacy, Penn Monthly, and the Massachusetts State Board of Health.

The Committee on Dr. Valentino's Memoir reported progress, and was continued.

The death of Dr. Geo. Allen was announced by the Secretary, and on motion Prof. Thompson, of the University of Pennsylvania, was appointed to prepare an obituary notice of the deceased.

Mr. Price communicated the following circular, read and

Digitized by Google

unanimously adopted at a meeting of the Commissioners of Fairmount Park, held June 5, 1876:

TREES FOR THE FAIRMOUNT PARK.

This Park is in the earliest stage of its formation. A principal feature of its beauty must consist of trees, planted in manner to form pleasing landscapes, and in trees planted singly, in groups, and groves. The Commissioners desire also to add a botanical interest to the Park, by having in it every tree that will stand our climate. To promote this object and duly to honor the name of Michaux, father and son, the American Philosophical Society have devoted half the income of the legacy left by the son to the Society, of about three hundred dollars ($300) per annum. This has been applied to the planting of the Michaux Grove of oaks, and to importing and planting in our nurseries many varieties of oaks, &c. The announcement is now made, during the holding of the Centennial International Exhibition as an auspicious occasion to invite contributions of trees, acorns and seeds, from all parts of the world, and from all persons who love the beautiful in landscape and to promote botanical science.

Communications may be made to Eli K. Price, No. 709 Walnut Street, Philadelphia, Chairman of Committee on Trees and Nurseries in the Park Commission, and Chairman of the Committee on Michaux Fund in the American Philosophical Society.

Mr. Price exhibited specimen twigs, bearing leaves, broken from every variety of oak imported and growing in the Michaux Grove. Respecting this grove he desired to have this minute placed on the Journal of the Society.

The Chairman of the Committee on the Michaux Grove reports, that he has visited to-day the Fairmount Park Nursery, and found the grounds well taken care of, and the large stock of trees in a flourishing condition. Of the acorns planted before last winter nearly all have grown except those of the "Bartram Oak;" and of the fifty or sixty of these planted, not one has grown. So far the proof is in favor of that oak being a hybrid.

Mr. Davenport being invited to speak of the Eucalyptus trees of Australia, and the probability of growing certain species of Eucalyptus in our latitude, remarked that his botanical information was drawn chiefly from the pretty thorough reconnoisance of that continent by Dr. Schomberg, Director of the Botanical Gardens at Adelaide, and Baron

Digitized by Google

von Müller, Director of the Gardens at Melbourne, who recognized about one hundred and fifty species or varieties of Eucalyptus, many of large size, some growing grandly on arid plains, others on Australian "Alps" and "Pyranees" at various elevations; the highest mountain summits being not above 7000 feet over sea level. Some of these mountain kinds will probably grow in Philadelphia, and he will be happy to assist their introduction. He had seen large plantations of Eucalyptus between St. Jose and San Francisco, and others growing in the interior. He had come to the conclusion in his own mind many years ago that the fragrance diffused through the Australian atmosphere by the essential oils of these trees must account in part for the remarkable immunity which settlers and travelers, however exposed at night in the bush, had always enjoyed against malarious fevers, although the climate was as hot as in malarious districts of Italy. No malaria was known, although low typhoid fevers were not unknown.

Mr. Davenport remarked the great difference between the vegetation of Adelaide and Philadelphia, and had been much impressed by the exuberant foliage of the Park around the Centennial grounds.

Prof. Houston reported the result of his proposed experiment with the 19″ Fresnel lens through which, about two weeks ago, he had concentrated the beams of a full moon in a spot of about a quarter of an inch diameter, on the flags of a Crooke's radiometer, without obtaining the least movement; whereas the same instrument, at the same time, was moved by the heat of boiling water in a glass tube, but was not sensitive to radiant heat below about 212°. In a room, however, the heat of the hand would move it, a lighted match would make it move swiftly, even the dull red glow of the extinguished end of a match gave a sensible motion.

Pending nominations 793 and 803 were read.

And the meeting was adjourned.

Digitized by Google

Stated Meeting, July 21, 1876.

Present, 6 members.

Dr. LeConte in the Chair.

The reading of the minutes was dispensed with.

Letters of acknowledgment were received from Mr. C. E. Dutton, dated Omaha (97), and Mr. A. H. Worthen, Warsaw, Ill. (97).

A letter of envoy was received from the Smithsonian Institution, dated Washington, July 20.

A letter was received from Prof. Charles E. Anthon, dated College of the City of New York, June 29, 1876, with the coin and description referred to in his letter of February 11th, read at the meeting of February 18, 1876.

A letter was received from Mr. Charles A. Kesselmeyer, dated 1 Peter Street, Manchester, England, 21st June, 1876, presenting to the Society a copy of his "Calendarium Perpetuum Mobile," and enclosing a photograph with an explanation of the same.

Donations for the Library were received from the Berlin Physical Society; German Geological Society; Royal Prussian Academy; Dr. L. Wedekunde; Bamburg, Freiburg, and Chemnitz Natural History Societies; F. Kramer; Ulm Antiquarian Society; Royal Academy of Belgium; Royal Academy, Amsterdam; Netherland Botanical Society at Nimegen; Paris Geographical Society; Bureau des Longitude; Annales des Mines; Academy of Medicine; Editors of Nouvelles Météorologiques and Revue Politique, Paris; Col. E. Belleville; Turin University Observatory; G. Mazzola; Prof. A. Dorna; Society of Arts, Victoria Institute, Royal Asiatic, and Astronomical Societies, and Nature, London; Royal Society, Tasmania; Academy of Arts and Sciences, Connecticut; Silliman & Dana; Yale College; Mr. Osman Fisher; Essex Institute, Salem; Peabody Institute; Editors of American Chemist; Dr. C. H. Berendt; Pharma-

Digitized by Google

ceutical Association; Editors of the Penn Monthly; Franklin Institute; Editors of the Medical News and Journal; Mr. Robert Briggs, C.E.; Baltimore Peabody Institute; United States National Museum; Geological Survey of the Territories; G. B. Goode; Dr. Newberry; East Tennessee University; Academy of Science, St. Louis; G. A. Engelmann; and Hudson Hall, Savannah.

A donation for the Cabinet was received from Prof. Charles E. Anthon, of a coin of 1670, the date of the settlement of Quebec, struck by order of Louis XIV., the first currency of French North America.

The death of Prof. J. J. Kaup, of Darmstadt, was announced by letter of Prof. Joseph Henry, dated July 20, 1876.

A communication received from Prof. Charles E. Anthon was entitled, "On a Silver Louis of Fifteen Sous, struck under Louis XIV. for circulation."

Prof. Chase communicated a note on suggestions of Cosmical and Kinetic Harmony by Profs. Alexander, Pierce, Lovering, and others, and on some of the mathematical principles involved.

Pending nominations 793 and 803 were read and balloted for.

The letters of Prof. Henry and Charles A. Kesselmeyer were referred to the Secretaries with power to act.

On scrutiny of the ballot boxes, the following persons were declared by the presiding officer duly elected members of the Society, viz:

Prof. Richard Ackerman of Sweden.

Prof. John Johnson of Middletown, Conn.

And the meeting was adjourned.

Digitized by Google

Stated Meeting, August 18, 1876.

Present, 6 members.

Vice-President, MR. FRALEY, in the Chair.

The minutes of the last meeting were read.

Letters of envoy were received from the Smithsonian Institution, U. S. Coast Survey Office, London Meteorological Office, Boston Society of Natural History, and Gen. Henry L. Abbot.

Letters of acknowledgment were received from the Boston Society of Natural History, July 28th, (XV, ii.; 94, 97); Royal Astronomical Society, London, July 11th (XV, ii.; 62, 88); East Tennessee University, Knoxville, July 22d (97); and various libraries and members receiving Proceedings No. 97.

A letter was received from Prof. G. A. Matile requesting the loan of archæological specimens from the Cabinet to make casts from them for the Princeton Museum.

Photographs of Prof. Thomas C. Archer and Dr. H. R. Göppert were received for the Album.

Donations for the Library were received from the Academies at Berlin and Bruselles; the Congress of Naturalists at Berlin; the Societies at Marburg, Görlitz, Bremen, and Bordeaux; Zoological Garden at Frankfort; Geographical Society, Editors of the Revue Politique, and M. P. Frémeaux, at Paris; Royal Astronomical Society, Mr. T. H. Tizard, Mr. J. M. Stuart, and Editors of Nature, London; Geological Survey of Canada; Silliman & Dana, New Haven; Editors of the Penn Monthly, Medical News, and American Journal of Pharmacy, Philadelphia; Gen. H. L. Abbot; U. S. Coast Survey; Dr. Newberry, and the Rio Janeiro Museum.

Mr. Chase remarked upon the closeness of agreement between the estimates of solar radiating force derived from Crook's Radiometer and from the Nebular Hypothesis.

Digitized by Google

Dr. Cresson described successful experiments with Wootten's method of utilizing coal dust in locomotives and ocean steamers, and in puddling iron; exhibiting samples of the iron refined in the process.

New nomination 804 was read.

Mr. Fraley reported as received and paid to the Treasurer the interest on the Michaux Legacy, due July 1, 1876.

On motion of Mr. Chase, seconded by Dr. LeConte, the Curators were authorized to furnish Profs. Guyot and Matile such antiquities as they may wish to copy, taking the usual guarantees for their safe return.

Applications of Messrs. Trübner & Co., and others, for copies of Transactions and Proceedings, were referred to the Librarian with power to act.

And the meeting was adjourned.

Stated Meeting, September 15, 1876.

Present, 15 members.

Vice-President, MR. FRALEY, in the Chair.

Letters of acknowledgment were received from the Leipzig Astronomical Society, dated May, (xiv., 93, 94, 95); the Teyler Foundation, Harlem (94); the Royal Society of Science, Göttingen, April (XV, 94); the Central Institute of Meteorology at Vienna, June (93, 94); the Royal Academy, Amsterdam, March 12 (XV, i. ii., 94 and XV, 93); the U. S. Naval Observatory, Washington, June 30, (97); and the Zoologico-Botanical Society, Vienna, May (92).

Letters of envoy were received from the Royal Observatory, Turin, dated July 18; Royal Academy, Amsterdam, December 15, 1874; Mr. Geo. Engelmann, St. Louis, July 6; the Department of the Interior, and the Department of State, Washington, June 29th and August 17, 1876.

Digitized by Google

Donations for the Library were received from the Academies at Copenhagen, Brussels, Rome, and Philadelphia; the Geological, Zoological, and Anthropological Societies at Vienna; the Art Union at Ulm; the Geographical Society, Editors of Nouvelles Météorologiques and Revue Politique, at Paris; the Antiquarian Society, Dr. Joseph Prestwick, and the Editors of Nature, in London; the Melbourne Mining Survey; Maine Historical Society; Essex Institute; Dr. H. Carrington; Boston Society of Natural History; Hon. R. C. Winthrop; Dr. S. A. Green; Silliman & Dana, New Haven; Editors of the American Chemist; Prof. G. A. Matile, Franklin Institute, College of Surgeons, and Editors of the Penn Monthly, Medical News, and Journal of Pharmacy, in Philadelphia; U. S. Departments of War and State, Surgeon General, and Signal Service Bureau, Washington; Editor of the Scientific Monthly at Toledo; U. Stempel at Chicago; and Dr. Jarvis of Dorchester, Massachusetts.

A photograph of Dr. T. S. Hunt was presented for insertion in the Album.

A letter from Prof. J. Henry, requesting attention to a letter from the Holland Society of Science, was referred to the Librarian with power to supply deficiencies in the series of A. P. S. Publications in the Library of that Society.

A letter from the Freiburg Natural History Society was referred to the Librarian with power to supply Proc. 89.

A letter respecting deficiencies was received from the Society at Würtemburg and referred to the Librarian.

A letter from D. S. Sheldon, Librarian of Griswold College, Davenport, Iowa, asking for Dr. Hor. Wood's memoir on Myriapoda was referred to Dr. Wood.

A circular was received from the Société des Voyages at Paris.

Mr. Lesley exhibited a neatly executed colored geological lithograph map of Mr. B. S. Lyman's Official Survey of the Island of Yesso, as the first work of the kind done in Japan.

Digitized by Google

Dr. Hunt, on invitation, described the history of geological opinion respecting the gneisses, green rocks and other metamorphic strata of the Alps, with the recent accordance of the views of Gastaldi and Favre, as opposed to those of Lory and others, with previously published views of his own, after he had recognized the Laurentian, Huronian and Montalban systems in the massif of Mont Blanc.

Pending nominations Nos. 804, 805, 806, and 807 were read.

On motion the use of the Hall was granted to the Commissioners of the Geological Survey for their meeting on the 19th inst.

On motion of Mr. Pearse it was resolved, That the Board of Commissioners be requested to recommend to the Governor of Pennsylvania the propriety of taking such measures as may be necessary for preserving the collections of the Geological Survey in the same place in which the collections presented by the Commissioners of foreign governments may be arranged.

And the meeting was adjourned.

Stated Meeting, October 7th, 1876.

Present, 10 members.

Secretary, Dr. Le Conte, in the Chair.

Dr. Moor, a newly elected member, was introduced to the presiding officer and took his seat.

A letter of acknowledgment was received from the Observatory at Prague, dated Sept. 4 (XV, ii, 93, 94), from the R. Geological Society of Ireland, Sept. 16th (XIV Proc.), and from various correspondents by postal cards (97).

Letters of envoy were received from the Society at Marburg, April 1876;—the French Ministry of Public Works, Sept. 1876, desiring a return donation of some books on civil engineering or technology for the library of the Ecole des Ponts

Digitized by Google

et Chaussées in Paris; from the Linnean Society, dated London, Aug. 18th; from the Meteorological Office, dated London, Aug. 1876; from the Secretary of the State of Illinois; and from the Davenport (Iowa) Academy of Natural Sciences, Sept. 15th, desiring complete sets of Transactions and Proceedings.

A letter was received from Mr. C. A. Kesselmeyer, 1 Peter Street, Manchester, England, presenting a copy of his Card Calendarium.

Donations for the Library were received from the R. Belgian Academy; French Ministry of Public Works; Annales des Mines; Nature; Linnean Society; Society of Antiquaries; R. Geological Society of Ireland; Silliman and Dana; Editors of the American Library Journal and Medical News; Buffalo Society of Natural Sciences; and the Davenport Academy of Natural Sciences.

Professor Houston made an exhibition of a new telegraphic machine called a "Pneumo-dynamic Relay Sounder," where the local battery is replaced by compressed fluid, and explained it by a working model and diagram. Attached to the armature is a bent lever, with a valve mechanism opening and closing a conduit leading from a reservoir of condensed air. The issuing air swells out a diaphragm of rubber cloth covering a space of one sixty-fourth of an inch, and moves a disc, which moves the striking lever, the return stroke being effected by a spring. The balance of the valve is so adjusted as to diminish for opening the valve. This is affected by an accessory diaphragm pressing upon the other arm of the bent lever; the tension is then equal to the adjusted difference. The instrument works with rapidity enough to get responses easily to thirty-six beats per second.

Pending nominations Nos. 804, 805, 806, 807, and new nomination No. 808, were read.

On motion of Mr. Gabb, the committee on Dr. Valentino's paper was requested to report at the next meeting.

And the meeting was adjourned.

Digitized by Google

Stated Meeting, October 20th, 1876.

Present, 20 members.

Vice-President, Mr. FRALEY, in the Chair.

Letters of acknowledgment were received from the J. V. N. in Würtemberg, dated Stuttgard, June 24th (complete set of T. & P); the Swiss Society at Berne (92–96), and Professor C. E. Anthon, dated New York, Oct. 19.

Letters of envoy were received from the Swedish Academy, Stockholm, July, 1876; Royal Saxon Society, Leipzig, June 1; Swiss Society, Berne; and Royal Belgian Academy, Bruxelles.

Donations for the Library were received from the Academies at St. Petersburg, Stockholm, Copenhagen, and Bruxelles; the Observatories at St. Petersburg, and Prague; the Geological, Geographical, Zoölogical, and Meteorological Institutions at Vienna; the German Geological Society, Berlin; the Saxon Society at Leipzig; the Societies at Stuttgard, Ulm, Bern, and Lyons; M. de Koninck at Brusselles; the Geographical and Antiquarian Societies at Paris; the Geographical Society, the Victoria Institute and Nature, London; the Glasgow Philosophical Society; Melbourne Inspector of Mines; 'Canadian Journal; Essex Institute; Boston Nat. Hist. Society, and Massachusetts Commission to the Centennial; Cambridge Museum; American Antiquarian Society; Franklin Institute; Penn Monthly; Journal of Pharmacy, American Journal of the Medical Sciences; and Engineer Department of the United States Army.

Donations for the Cabinet were reported from Professor Guyot, of copies of original antiquities in the Museum of Princeton College, made by Professor Matile, who, with these copies, returned to the Cabinet the originals loaned to him from the Poinsett collection, having made copies of them for the Princeton Museum. Other originals were then selected to be copied and returned in due order.

The Secretary, in exhibiting these donations, said that they

Digitized by Google

were copies of prehistoric remains: snakes, tortoises, and other bizarre figures, found in Porto Rico.

He had suggested to Professor Matile that certain duplicates in the Poinsett collection might be exchanged for duplicates in the Princeton collection. Mr. Matile and Mr. Guyot subsequently requested that the Society would consider a request for such exchanges; Mr. Matile selected duplicates; and the Secretary displayed specimens of the selection to show in what form the exchanges might be effected.

The death of Sir William Jardine, and Dr. John Hughes Bennett, of Edinburgh, members of this Society, was put on record, the Smithsonian Institution having returned copies of the Proceedings so marked.

The Committee on Dr. Valentino's Memoir reported that they considered it advisable to return it to the author for certain emendations, which, on motion, was so ordered.

Dr. Genth reported his discovery of a new mineral, the telluride of mercury, in the Keystone Lode, Magnolia District, Colorado. Further investigations are in progress and will be reported. The ore contains no silver. Native mercury is said to have been noticed in the mine.*

Pending nominations 804, 805, 806, 807, 808, and new nominations 809, 810, 811, 812, were read.

Ballots were then cast for Nos. 804 to 808.

The subject of providing additional conveniences for the members in the rooms of the Society was referred to the Hall Committee with power to act.

The formal application of Mr. Wooten for the premium of $500 for inventing a successful method of using anthracite slack was referred to the Officers and Council.

On motion, the subject of exchanges of duplicates with the Princeton Museum was referred to the Curators, with instructions to report their action at the next meeting.

Mr. Lesley communicated the fact of experiments being made at Johnstown, by order of the Geological Commission, to obtain some reliable facts about the conduct of mixed an-

* Dr. Genth has named the new species *Coloradoite.*

Digitized by Google

thracite and bituminous slacks, with and without pitch, in the coke oven.

Mr. Briggs urged the need of circumspection in offering and decreeing premiums to inventors before continuous and complete success; and instanced the use of all the anthracite slack in the manufacturing establishments of New England for the last twenty years, by a variety of methods, all of them successful. In respect of the mixed anthracite and bituminous slacks his experience had been that their combined clinkers were so much worse than the clinkers from either one separately that the mixture could not be used in the fire box.

The meeting was adjourned after scrutiny of the ballot boxes by the presiding officer, who declared the following persons duly elected members:

Mr. Samuel Davenport, of Adelaide, Australia.
Dom Pedro d'Alcantara, Emperor of Brazil.
John F. Hartranft, Governor of Pennsylvania.
Mr. W. Milnor Roberts, of New York.
Mr. Aug. R. Grote, Director Mus. Buffalo S. N. H.

Stated Meeting, November 3rd, 1876.

Present, 13 members.

Vice-President, Mr. Fraley, in the Chair.

Letters accepting membership were received from Mr. Samuel Davenport, dated Main Cent. Building, Phila., Oct. 26; Mr. A. R. Grote, dated Buffalo, New York, Oct. 26; Mr. John Johnston, dated 812 Broadway, N. Y., Oct. 31, 1876.

A letter from Professor Jos. Henry, dated Smith. Inst. Washington, D. C., Oct. 27, requested a set of Transactions for the Wellington Museum, in New Zealand, under the charge of Dr. Hector, Director of the Geological Survey. On motion the request was granted.

Donations for the Library were received from Mr. Levi Capron (Kaiticushi, Tokio, Japan); the Academies of Ber-

Digitized by Google

lin and Brussels; the Societies at Ulm and Bath; the Geographical Society and Meteorological Office; and Nature; the Mass. Hist. Soc.; Silliman's Journal; Penna. Historical Society; Penn Monthly; Librarian of Congress; Kentucky Geological Survey; Mexican Geographical Society; Professor R. S. McCulloch and Mr. Samuel Davenport, of New Holland.

A circular letter from Dr. Aug. Le Jolis, dated Cherbourg, Oct. 12, respecting the 25th Anniversary (Dec. 30), of the Society of Science, was on motion referred to the Secretaries to be suitably answered, after being signed by the President.

A communication, entitled "On the Atmosphere of the Sun and Planets, by David Trowbridge, A.M.," (Professor at Waterburgh, Tompkins Co., N. Y.) was received from Professor Kirkwood, of Bloomington, Ind.

Professor Chase made a verbal communication of his views respecting intramercurial bodies revolving around the Sun.

Mr. Briggs described the difficulties in the way of a successful discussion of the type form of the *vena contracta* in hydraulics.

Professor Houston continued the topic, and added remarks upon the nature of the form and movements of the "ventral segments," especially in cases where musical vibrations were employed to effect them.

Pending nominations Nos. 809, 810, 811, 812, were read.

The curators reported, recommending the proposed exchange of duplicates with the Princeton Museum. The report was accepted and adopted.

And the meeting was adjourned.

Stated Meeting, November 17th, 1876.

Present, 17 members.

Vice-President, Mr. Fraley, in the Chair.

Mr. W. Milnor Roberts, a newly elected member, was introduced to the presiding officer and took his seat.

Digitized by Google

A letter accepting membership was received from Mr. W. M. Roberts, dated, Bristol, Pa., Nov. 5, 1876.

Letters of acknowledgment were received from the Foundation Teylor, Harlem (95, 97), and the Danish Academy at Copenhagen, Oct. 17 (95).

A letter of envoy was received from the Board of Commissioners of the Second Geological Survey of Pennsylvania, Harrisburg, Nov. 16, 1876.

Donations for the Library were received from the Editors of the Mining Survey of Melbourne; the Academies at Vienna and Copenhagen; the Society at Lausanne; the Revue Politique and London Nature; Mr. Scudder, of Boston; Mr Packard, of Cambridge; Yale College; Professor E. D. Cope; Editors of the American Chemist; Medical News and Journal of Pharmacy; Franklin Institute; the Geological Survey of Pennsylvania; and the Department of the Interior.

On motion, the bill of Mr. Hall for repairs of the roof was ordered to be paid.

On motion, the Librarian was authorized to exchange the Proceedings for Poggendorff's Beiblätter.

The death of Judge Walter A. Lowrie, at Meadville, Nov. 14th, aged 69, was announced by Mr. E. K. Price.

A communication, entitled "Remarks on the Tonkáwa Language" by Mr. Albert S. Gatschet, was presented by Dr. Brinton, with a personal notice of the author, well-known for his work on the geographical nomenclature of Switzerland. He was connected with Von Ruprecht and others on the Wheeler Expedition, and has a book in the Weimar press describing twelve Indian languages of the Southwest. The materials from which he has made the well-written and valuable communication to this Society are all original or unpublished.

Dr. Cresson exhibited a bottle of nauseous smelling well water from near Trenton, N. J., which his analysis showed to contain no animal organic impurities, although a cesspool stood at the distance of two hundred feet; but about one

Digitized by Google

hundred pounds of vegetable organic impurities (in the million gallons) derived no doubt from a marsh situated higher up the slope of the hill, and about a quarter of a mile off, or from truck farms in the same direction a half mile distant. The drainage seems to break down, through the loam and clay cover, into the rock, and find its way by the bed-plates or cleavage-planes to the well.

Professor Frazer adduced an instance where the water of a well at least forty feet above the level of the Jenny Jump Mountain Great Marsh, in Northern New Jersey, was made poisonous in hot dry seasons especially, by the upward percolation of marsh water.

Dr. Cresson said that in the dryest times the subsoil on the heights of Broad Mountain in Schuylkill Co. Pa. was always kept damp by upward percolation.

Professor Frazer described his observations at a recent visit to the Bamfordville Zinc Works in Lancaster Co. Pa. a mile east of Landisville, superintended by Mr. Spilsbury. The deposit is of great interest to the geologist as well as profit to the owners. Instead of being a carbonate, or silicate, or mixture of these two species of zinc ore, as at Saucon near Bethlehem, and in the Western States, it is a sulphide, a very light yellowish brown zincblende, sometimes quite colorless.

He described the process of treating the ore by crushing; bolting into four or five grades of fineness; jigging, or as to the finest grade buddling; and immediately roasting while wet, fresh from the jig. By using the *wet* material Mr. Spilsbury claims that he desulphurizes more readily. The roasted ore is then retorted with fine anthracite dust, and to the mixture Mr. Spilsbury adds 1 to 1. 5 per cent of salt, claiming to get thereby 5 to 6 per cent more zinc from the ore than he could without the use of the chloride. Professor Frazer was desirous of obtaining the opinions of experts on the two points thus observed.

[*Continued on page* 333.]

Digitized by Google

Silver Louis of Fifteen Sous, struck under Louis XIV., for Circulation in French America.

By Charles E. Anthon, LL.D.,

PROFESSOR OF HISTORY AND BELLES-LETTRES IN THE COLLEGE OF THE CITY OF NEW YORK.

(*Read before the American Philosophical Society, July 21st,* 1876.)

Description--Silver. LVD · XIIII · D · G · [Mint-mark, Sun in splendor, the badge of Louis XIV.] FR · ET · NAV · REX · (Louis the 14th, by the grace of God, King of France and Navarre.) Bust of Louis XIV., laureate, to the right, in corselet and mantle; margin serrated. *Rev.* GLORIAM · REGNI · | TVI · DICENT · ("They shall speak of the

glory of thy kingdom,") 1670. On a crowned shield, three *fleurs-de-lis* (two and one). Above the crown, a crowned A; beneath the shield, between the dot after REGNI and the dot before TVI, A (for Paris, the place of striking); margin serrated. Size 13, scale of the Philadelphia Numismatic Society, *i. e.*, thirteen-sixteenths of an inch. Condition, barely circulated.

Although there has existed among us, for the last quarter of a century, a very considerable degree of interest in the subject of our pre-revolutionary coinage, and although the taste for collecting and studying such specimens of it as can be procured has steadily increased, till the majority of the rarer and more remarkable pieces extant have found their way into the cabinets of collectors, to the great enhancement of the price of those which remain in the market, and with a corresponding whetting of the appetite to possess them on the part of antiquarians, it strangely happens that the beautiful coin represented above, demonstrably American, and suggestive of important historical remembrances as it is, has remained neglected and unsought for. No author on American Numismatics seems to have been aware of its existence until the present writer, in Vol. IV., No. 9, for January, 1870, of the American Journal of Numismatics, which he then edited, called the attention of its readers to the fact. A brief and unsatisfactory notice of it, not founded, as is confessed, on actual inspection, forthwith appeared in Sandham's "Supplement to Coins," &c., of Canada, Montreal, 1872; the main work, published in 1869, being silent on the matter. But Mr. Sylvester S. Crosby, of Boston, who has lately (1873–1875) produced the last and best work on the general subject, entitled, "The Early

Digitized by Google

Coins of America, and the Laws governing their Issue," and proves himself, on every page of it, to be a diligent and conscientious laborer, thinks himself called on to adopt an apologetic tone when mentioning this piece, and to speak of it as "not strictly included in our original plan." Yet his purpose, or "original plan" was, in his own language, "to give all the trustworthy information at" his "command, relative to such coins, or tokens, which were intended to serve as coins, that were either struck in those parts of America which now constitute the United States, or were intended for use therein;" and it cannot be controverted that this is the earliest official coin of a region embracing at least half of the States which now constitute the Union. We are not perhaps, in general, sufficiently alive to the truth that, from the Atlantic to the remote West, the beginnings of colonization were chiefly made by France. Not Canada and Louisiana, merely, formed the French America of a once far from improbable future. In an authority easy to consult, Bancroft's History of the United States, Vol. II., we find a "Map of French, English, Dutch, Swedish and Spanish possessions, or claims in the United States, in 1655." A narrow strip from the Kennebec to Cape Fear, is all that is marked as not French, to the northward of Florida. A large part of Maine, all West Virginia, South Carolina, Georgia, the greater part of New York and of Pennsylvania, and from these all westward, as far as exploration had then extended, are French. Every one of the States comprehended within the area thus roughly denoted, may regard the coin in question as its earliest monetary relic.

Without, however, going back to years anterior to its date, or looking away from the broad double valley, which extends between the Alleghanies and the Rocky Mountains, or including States of which any portion lies outside of these limits, we can easily, we think, form a list of fifteen, in each of which the collector, present and to come, must regard this "Gloriam Regni" of 1670, as its most ancient numismatic monument. The reader of history is aware that "Louisiana" was, in 1712, defined by authority as comprising all the country drained by waters emptying directly or indirectly into the Mississippi; while the schoolboy has been taught that, out of the "Louisiana purchase" of 1803, alone, have already been formed fifteen States and territories, eight of the former and seven of the latter. Since it happens that, in the article already referred to (American Journal of Numismatics, Vol. IV., No. 9, for January, 1870), the present writer, just two centuries after the first appearance of this coin, introduced it to American collectors as a new "Colonial," not known to them before, and proper to take the place usurped by one familiar to the numismatic fraternity under the name "Louisiana copper," or "R F," he must now again insist on the correctness of this view, and re-affirm that the GLORIAM REGNI is the earliest colonial coin of at least half the States of the Union. Of course we do not mean that it actually circulated in the whole vast region mentioned; but it may have appeared accidentally in any part thereof, and, wherever it did so appear, it was, in the

Digitized by Google

estimation of any Frenchman who might behold it, the coin of the realm which he trod.

It is, then, our oldest French "Colonial." Mr. Crosby may boldly represent it as such in his next edition. No apology will be required. Both he, indeed, and his predecessors, needed rather to defend (as he attempts to do), or, in fact, avoid altogether, the introduction of the "Sommer Islands," (or Bermuda) patterns for shilling and sixpence, in a work on the coinage of the United States, where they can have no just claim to stand.

With a few brilliant exceptions, our prominent numismatic collectors, and even authors, have not been men of much research or of a wide range of reading. They have delved with greater or less industry in a narrow field; and authorities, other than those in English, have not occurred to them. Hence works of some rarity, like Le Blanc's Treatise on the Coins of France, or of great commonness, like the New France of Charlevoix, which latter, as we shall soon proceed to show, contains most satisfactory corroboration of the American character of the coin of Louis Quatorze before us, with a tolerably ample history of it, have equally escaped their notice. As John Smith's History of Virginia, on the other hand, includes a full account of the Sommer Islands pattern, and is a familiar book, in English, they have, through a natural confusion of localities, inadvertently come to regard that coin as a United States "Colonial" one.

Moreover, this GLORIAM REGNI, or French-American piece of Fifteen Sous, is a very rare coin. I infer from the first of the two French authorities whom I have named—and I shall presently quote his exact words—that only one hundred thousand livres' worth of 15-sous pieces and 5 sous pieces, together, was struck in 1670, and none at any subsequent date. The "livre," now obsolete, was one-eightieth less in value than the present franc, and, like the franc, contained twenty sous. Personally, I know of the existence of only five specimens. I have had the good fortune to obtain two, both in very fine condition, from two different auction-sales of coins in Europe, and one of these I have now the honor of presenting to the American Philosophical Society, with an accompanying wood-cut made expressly for the illustration of this paper; a third, seemingly in a poor state of preservation, if we may judge from its heliotype likeness in Mr. Crosby's work, plate III, No. 5, is in the cabinet of that accomplished scholar and numismatist, William S. Appleton, of Boston; the fourth had, from its appearance, and the locality where I met with it, in all probability been circulated in America. It was in the collection of Mr. J. Myshrall, at Frederickton, New Brunswick, where I saw it in 1870, towards the end of the summer. It showed marks of rough treatment, and must, I think, in passing from hand to hand, have reached, from Lower Canada, the town where it came under my observation. The fifth has been shown me since I began to write this communication, by its owner, Mr. Henry Mott, at present of Brooklyn, but formerly of Montreal.

Digitized by Google

It bears slight marks of circulation, and was obtained in the latter city. Hence it too, probably, was once in actual use.

And here I have a remark to make: that it is a somewhat unreasonable, albeit almost universal, trait of collectors of coins, to strive to obtain them in a condition, if possible, uncirculated, or at least nearly approaching that state. Yet it is evident that marks of actual service, provided they have not obliterated the legend or seriously impaired the device, ought to give a heightened interest to these objects, as proving them to have been handled by the people of their time. The desire to possess a collection, which, in mechanical and artistic beauty and brilliancy, may compare favorably with others, seems, however, to transcend, with most numismatists, every other consideration; and accordingly a coin, which may be called still-born, inasmuch as it has, by some accident, been snatched from a coin's virtual existence, which is its circulation, on the very threshold of such real life, has always commanded, and will continue to command the preference.

But it is now time to authenticate our GLORIAM REGNI, and establish, by evidence, that it is entitled to the estimation which we claim for it. In the "Historic Treatise on the Coins of France, from the commencement of the Monarchy to the present time," by Mons. Le Blanc, Paris, 1703, we read at page 388: "In order to facilitate commerce in Canada, the King caused to be struck a hundred thousand livres' worth of Louis of 15 sous, and of 5 sous, and Doubles of pure copper. These coins were of the same value, weight, and fineness with those of France. On the silver Louis of 15 sous and 5 sous, in place of the *Sit nomen Domini benedictum*, there was *Gloriam regni tui dicent*, and on the Doubles, *Doubles de l'Amerique Françoise*." The specimen which I transmit to the Society, must therefore, as its size and intrinsic value denote, be one of those of Fifteen Sous. I am much inclined to doubt whether the Louis of five sous was really struck, since I have never seen one or heard of one as actually existing. Nor is any "Double" to be found, as far as I know, among American collectors, though the inhabitants of Lower Canada and of the French West India Islands have in all likelihood preserved some few examples. Mr. Crosby's heliotype portrait of the piece, plate III, No. 6, is as he informs us, not taken from a genuine one.

In a letter written at Quebec, Feb. 15, 1721 (Nouvelle France, Vol, III, p. 91), Charlevoix gives us the following information on our subject: Commerce in Canada was depressed by nothing perhaps more than "the frequent changes which were made there in the coins. I will give a brief account of the matter. In 1670, the West India Company, to which the King had ceded the dominion over the Islands of the French American Continent, had permission to introduce into the Islands small money to the amount of a hundred thousand francs, stamped by a particular die, with a legend which was peculiar to it. The King's edict is of the month of February, and was to the effect that these coins should be current only in the Islands. But on certain difficulties, which supervened, the Council

Digitized by Google

issued, on the 18th of November of the year 1672, a decree by which it was ordered that the money aforesaid, and all other specie, being current in France, should also be current, not only in the French Islands but also on the terra-firma of America subject to the crown, with an augmentation of one-fourth superadded; that is to say, the pieces of fifteen sous for twenty, and the others in proportion."

"The same decree ordered that all contracts, bills, accounts, purchases and payments should be made between all descriptions of persons, in money, without privilege of barter or accounting in sugar, under penalty of nullity as to transaction. And in regard to the past, it was ordained that all stipulations relating to contracts, or bills, or debts, or obligations, or rents in sugar and other provisions should be reduced into and made payable in money, at the valuation of the aforesaid coins. In execution of this decree, coin increased one-fourth in value in New France," &c., &c. Here we leave the amiable Jesuit to relate the financial mischief which ensued, and we quit the historic aspect of our theme for the æsthetic and literary.

As a work of art this coin is beautiful. It will, from that point of view, compare advantageously with any now produced in the home-mints of this country, where it was once intended to circulate. The portrait of Louis presents him as a handsome man of thirty-two, his age in 1670; the mint-mark of the sun in splendor recalls his famous motto: "*Nec pluribus impar*"—which, by the way, has a structural similarity to our own national one;—the manner of marking with a · subscript the final I in XIIII is very uncommon; I know no other instance of it on a coin. The reverse offers us, as a subject of remark, first, the legend: "*Gloriam Regni tui Dicent.*" It is taken from the vulgate of the fine Psalm CXLV., entitled "David's Psalm of praise." Verses 10–13 of our translation read as follows:

10. All thy works shall praise thee, O Lord; and thy saints shall bless thee.
11. *They shall speak of the glory of thy Kingdom*, and talk of thy power;
12. To make known to the sons of men his mighty acts, and the glorious majesty of his Kingdom.
13. Thy Kingdom is an everlasting Kingdom, and thy dominion endureth throughout all generations.

In the application of the beginning of verse 11 to the purpose of a numismatic legend, particularly if it be considered in connection with its context, two covert references seem to me to be intended; the first, to the highly ecclesiastical character of French colonization in America, in which exploration and conversion ever proceeded hand in hand; the second, to the "mighty acts" and "glorious majesty" of the "grand Monarque." It is true that he had not, at this comparatively early epoch in his reign, put forth the exaggerated pretensions which he afterwards advanced; but the adulation and irreverence which offend us in the use made of these words, were already in the taste and fashion of that day.

Our second subject of remark is the crowned A (such we take it to be) which appears above the royal crown which forms the armorial crest. In

Digitized by Google

the absence of any authoritative information on the subject, we may reasonably conjecture that it signifies French (or Royal) America, and, if this be so, the only characteristic needed to make this coin pre-eminent in interest among all American colonial pieces, that, namely, of having on its face a distinct mention of our Continent, is supplied.

In concluding this paper, of which the subject, and the treatment of the subject, will, it is hoped, not be found beneath the notice of the American Philosophical Society, the writer may be permitted to observe that the fact of its being presented in this our year of Jubilee, and at the moment whence, a century ago, our first grand "annorum series" began to proceed, is entirely accidental, resulting from the casual acquisition, at this time, of the specimen which accompanies it. There seems, however, to be an eminent propriety in calling to mind, on the present most interesting occasion, and also connecting with tangible objects of curiosity, however slight, the American history of the great ally who rendered such essential aid to the insurgent colonies during their doubtful struggle. In regard to matters like this, perhaps not likely to be remembered with sufficient tenacity, medals and coins perform an important service; while, to take a broader view, through their distinct marking of decisive epochs, they contribute to enable us, in the words of a writer of the illustrious nation referred to, "*vivre de la grande vie des siècles*"—to live in the great life of the Centuries.

---

*On some Fundamental Propositions of Central Force.**

By Pliny Earle Chase, LL.D.,

Professor of Philosophy in Haverford College.

(*Read before the American Philosophical Society, July* 21, 1876.)

All cyclical motions which are produced by the action of a central force are, necessarily, of an oscillatory character. They may, therefore, be mathematically represented by suitable modifications of simple pendulum equations, as Fourier has well shown.† The first attempt at a general discussion of such motions seems to have been made in 1827, by Dr. Henry James Anderson, Professor of Mathematics and Astronomy in Columbia College, whose paper‡ may be found in the third volume of the second series of the

* Whenever I speak of "central force," in the present paper, I refer to force varying inversely as the square of the distance.

† See, also, papers by David Rittenhouse, Trans. Soc. Phil. Am., iii; Jos. Clay Ib., v; Owen Nulty (suggested by Rittenhouse's), Ib. [2] i; James Dean, and N. Bowditch, Trans. A. A. S., iii; Robert Adrain, Trans. S. P. A., [2] i; Eugenius Nulty, Ib. [2] ii.

‡ "On the motion of Solids on Surfaces, in the two Hypotheses of perfect Sliding and perfect Rolling, with a particular examination of their small Oscillatory Motions." *Op. cit.* p. 315.

American Philosophical Transactions. The following quotation from his exordium is both prophetic and suggestive :

"There are few branches of Mechanical Philosophy as interesting in every point of view as the theory of Oscillatory Motion. From the minutest vibrations of a harp-string to the magnificent oscillations of a planet's axis, there are an infinite number of analogous phenomena remarkable for their curious properties or important uses. The common pendulum, that little instrument which has rendered such essential service to science and the arts, and will soon, in the hands of the skilful observer, unfold to us the internal constitution of our globe, and give a clue to the process by which it has acquired its present state, is itself indebted for its accuracy to the incessant superintendence of a watchful mathematical analysis. The science of Acoustics in all its parts, the varied phenomena of the tides, the theory of Saturn's ring, that wonder of the solar system, and the philosophical explanations of the stability and harmony of the celestial motions, are in fact, but different applications of this extensive branch of Demonstrative Mechanics. What adds to the interest and value of this subject is the circumstance that a large class of oscillatory motions, namely those of any rigid system whatever whose points depart but little from the position which they occupy when at rest, has been found susceptible of complete determination, by means of which the position of the bodies composing the system may be expressed (to use the language of analysis) in finite functions of the time."

In 1843, Professor Stephen Alexander communicated to the American Philosophical Society,* his observations upon physical phenomena which accompany eclipses. Among those phenomena was a "dragging of shadows," which he attributed, at the first meeting of the American Association (Philadelphia, 1848), to the inertia of the luminiferous æther. By this, and other like "scientific uses of the imagination," he was led to the discovery of a series of cosmical relations, some of which were laid before subsequent meetings of the Association, the whole being finally embodied in his "Statement and Exposition of Certain Harmonies of the Solar System."†

At the second meeting of the American Association, (Cambridge, 1849), Professor Benjamin Peirce read a paper "On the Relation between the Elastic Curve and the Motion of the Pendulum." "On this subject Prof. Peirce remarked, that the relations discovered merely by intellectual investigations, and not observed by the senses, are of peculiar interest, as manifesting the fact that one intellect presides over the production of those phenomena. Could we see in the moon a house like our own, we should say that it was built by men like ourselves, having similar wants, and using similar means to supply them, and we should say that the same being who formed our minds created theirs also. We cannot make such observations, but we may trace relations between objects with which we are

* Proc. Soc. Phil. Amer., May, 1843, vol. iii.

† Amer. Nat. Acad. Sci., 1873-4; Smithsonian Contrib., 280.

Digitized by Google

familiar, which lead us to similar results. At present the discovery of these relations has been very much confined to those subjects to which mathematics apply."* At a later session of the same meeting, Peirce presented a "Mathematical Investigation of the Fractions which occur in Phyllotaxis." After showing the influence of an identical law in the arrangement of plants and planets, he asks: "Whence could this extraordinary coincidence have arisen but from the action of a single mind? and what does it indicate but that the same Word which created the planet, is expressed in the planet? May I close with this remark, that the object of geometry in all its measuring and computing, is to ascertain with exactness the plan of the great Geometer, to penetrate the veil of material forms, and disclose the thoughts which lie beneath them? When our researches are successful, and when a generous and heaven-eyed inspiration has elevated us above humanity, and raised us triumphantly into the very presence, as it were, of the Divine intellect, how instantly and entirely are human pride and vanity repressed, and by a single glance at the glories of the infinite mind, we are humbled to the very dust."†

On the second of January, 1849, in a communication "On the Fundamental Principles of Mechanics,"‡ Peirce had already shown that "a system of bodies in motion must be regarded mechanically as a system of forces or powers which is a perfect representative of all the single powers of which the system is compounded, and this, too, at whatever time or times the component powers may have been introduced into the system. The question of the simultaneous introduction of the partial powers is of no importance. Any power which is at any time communicated to the system is preserved in the system unchanged in amount or direction."

At the same meeting of the Academy, Professor Joseph Lovering read a paper "On the Law of Continuity,"§ in which he said, "the method of analysis which began with Leibnitz and Newton, and which in England has been known under the name of fluxions, rests upon this law of continuity. If we admit the usefulness of the principle only in cases of motion, we still give it a wide range; since so many problems, not strictly dynamical, are reduced to cases of motion when investigated by the rules of modern analysis."

On the 4th of Feb. 1851,‖ "Professor Peirce gave an argument, which he thought to be new, against the principle which is usually adopted in theoretical works, that the force of a body in motion is its *vis inertiæ*. He believes, on the contrary, that the time is at hand when the *vis viva* will be universally recognized as the force of a moving body. His new argument is derived from the effect of a force in causing rotation, as well as translation. By the old theory, no additional force is required to produce rotation; whereas, by the theory of the *vis viva*, just as much force is re-

* Proc. A. A. A. S., II, 129.

† Ib., p. 446.

‡ Proc. A. A. S., II, 111.

§ Ib., p. 121.

‖ Ib., p. 256.

Digitized by Google

quired as is actually exhibited in the resulting rotation. The same argument may be derived in another form from the vibrations of elastic bodies."

The "Mathematical Monthly," for January, 1859, contained an exhaustive discussion of "The Motions of Fluids and Solids relative to the Earth's surface," by Professor William Ferrel, some of the results having been published about two years before, in the "Nashville Journal of Medicine and Surgery." The recent great advance in meteorological knowledge and in successful weather prediction is due, in great measure, to the publication of Ferrel's laws.

In 1861, Professor Simon Newcomb presented to the American Academy, a compendious review of the dynamical theory of gases.* His paper contains, among other matters of interest, the following first approximation towards a theoretical establishment of the empirical ratio between the temperatures under constancy of pressure and under constancy of volume: "7. If the particles were perfectly hard and spherical, the specific heat under constant volume would be to that under constant pressure as 3 to 5. If they were hard, but not spherical, this ratio would be that of 3 to 4. The latter result follows from an elegant theorem given by Professor Maxwell in Vol. XX, of the Philosophical Magazine, viz., that if the particles are hard, but not spherical, the sum of their *vires vivæ* of translation will be equal to that of their *vires vivæ* of rotation."

My first attempt at applying the foregoing principles was made in 1863,† when I showed that the daily fluctuations of the barometer are of such form and magnitude as can be explained by the combined action of atmospheric inertia, terrestrial resistance, and *motion* relative to the Sun. I also showed that the tendencies to equality of areas, in the daily and yearly fluctuations, furnish the data for a close approximation to the solar distance.‡

In 1864, Professor James Edward Oliver made a practical investigation of the best approximate representation of all the mutual ratios of *k* quantities by those of simple integers, drawing illustrations especially from phyllotaxis and planetotaxis. His investigation assumed that "Nature, while obeying with absolute precision the resultant of her efficient laws, such as Inertia, Attraction, etc., falls into forms which commonly both *utility* and *taste*, often independently of each other, would prescribe."§

In 1865, Ferrel described an annual variation in the daily mean level of the ocean, the greater part of which he attributed to "a tangential force arising from the motions of the ocean combined with the motion of the Earth's rotation. It was first brought out in its most general form in [his] paper on the motions of fluids and solids relative to the Earth's surface."‖

* Proc. A. A. S., v, 112.

† Proc. Soc. Phil., Amer., ix, 283.

‡ Ib., *loc. cit.*, and x, 376. See, also, Ferrel's paper of 1865, to which reference is made below.

§ Ib., vi, 288.

‖ Ib., vii, 35.

Digitized by Google

A few days ago, Dr. Thomas Hill, Ex-President of Harvard College, illustrated the danger of exalting science above philosophy. "The true aim of science is not merely to record the uniformities of nature, but to discover the intellectual ideal which binds them together. The human mind in the presence of phenomena * * * is always inclined to ask three questions: What is the invariable order of sequence? What cause produces the effect? For what end are they produced?"*

Each of these papers involves one or more of the following postulates, which are treated by many as scientific heresies, but which others regard as prolific truths.

1. Faith and Reason are both handmaids of Science.

2. Knowledge is not only power, but it is also supreme power, or the source of all power.

3. Order and harmony are evidences of Intelligence. The discovery of new harmonies should, therefore, always stimulate new scientific investigation.

4. There can be no law without a Lawmaker.

5. Unity of Intelligence indicates unity of law.

6. Æsthetic gratification points to efficient laws.

7. All empirical results rest on *a priori* principles.

8. The methods, are permanently recorded in the works, of Intelligence.

9. There can be no unbalanced physical force without motion Even forces which are *relatively* static, can only be fully studied when producing motion.

10. Simple physical force is always central. Therefore the laws of elasticity and of oscillatory motion are of prime importance in all fundamental physical investigations.

11. Any æthereal medium, through which impulses are progressively transmitted, must be material.

12. Any medium through which impulses are transmitted instantaneously,† must be devoid of inertia, and therefore spiritual.

13. Tendency of motion is always in the direction of least resistance. Radial and tangential oscillations naturally alternate.

14. If the force of a moving body is its *vis viva*, the average *vis viva* of a perpetual oscillation is the proper standard for determining its quantity of motion, and the average velocity is the velocity of an equivalent synchronous oscillation under uniform velocity.

Most of these postulates, like all hypotheses, theories and laws, fall within the domain of metaphysics. Physical science, properly so called, is limited to facts which are discoverable by the senses, and to their co-ordination in accordance with metaphysical requirements. Pure metaphysics tends to

* Address before the Alumni of Bowdoin College, July 12, 1876.

† The only instance of supposed instantaneous transmission is that of gravitating action. La Place s estimate of its least possible velocity has been variously and sometimes wrongly stated; in his *Mécanique Céleste*, X, vii, 22, he fixes it at 100,000,000 times the velocity of light, and says, "therefore mathematicians may continue to regard it as infinite."

Digitized by Google

dreaminess and paradox ; pure physics, if such a thing were possible, to worldliness and shallowness. Metaphysics strives to learn too much ; physics is satisfied with too little. Science deals both with the physical and with the metaphysical ; embracing all knowledge that bears, in any way, upon the religious, the ethical, or the intellectual needs of man. An exclusive regard to either phase of our triune nature leads almost of necessity, to shortsightedness and narrowmindedness. In the modern science of thermodynamics, the fertility of discovery, which has rewarded the labors of European and American investigators, furnishes abundant evidence of the usefulness of metaphysical anticipations as aids to physical research.

Newton looked to æthereal oscillation as a probable source of gravitation, finding it easier to imagine the approach of inert bodies through the influence of elastic thrusts, than to conceive of any practicable form of pull; Le Sage, adopting Newton's view, developed it with considerable detail, and later French Academicians have shown, in various ways, and to various extents, the likelihood of the hypothesis ;* Anderssohn has given an experimental demonstration of its sufficiency ; Norton and Challis have engaged in similar speculations, which they have extended so as to embrace all known forms of force ; Weber, Kohlrausch, and Clerk Maxwell have confirmed Faraday's partial identification of light and electricity by actual measurement ;† Faraday's cautious suggestion of "lines of force," proposed to treat all forces mathematically and independently of any hypotheses as to their nature, a proposal which has been largely and wisely followed by many recent investigators. As a further contribution towards such treatment I submit the following propositions, to which I have been led in the progress of my own researches, and which may be serviceable in other investigations.‡

Let f = velocity communicable, at distance r in time t, by any central force varying inversely as r^2.

f' = velocity communicated by a single impulse or in a single instant.

f_i = if' = " " by i equal impulses, or in i instants if the distance remains constant. Then

I. If the pressure resulting from f is constant, it must either be exactly

* For some of the most important of these papers, see references of W. B. Taylor, in Journal of the Franklin Institute, cii, 71.

†The 9th postulate may, perhaps, be made still more general by this measurement. That we know no instance of absolutely static force, is indisputable; the communication of momentum or *vis viva* by any physical agency which has no momentum nor *vis viva* is, to me, inconceivable; the consideration of electrostatic force as force static relatively to the Earth, and of electrodynamic force as force moving with the velocity of light, furnishes almost demonstrative evidence of a universally oscillating æthereal medium which may be the secondary or physical source of all physical motion and all physical force.

‡ Most of the propositions of Newton's Principia are applicable to all central forces.

Digitized by Google

counterbalanced by some opposing force or forces, so as to produce relative rest; or the motion must be maintained at a constant distance from the centre, so as to produce circular revolution; or, if the opposing force results from the transformation of interfering revolutions, the two conditions may be combined so as to produce rotation. The velocity of circular revolution $= \sqrt{fr}$; the velocity of rotation $= \sqrt{fr} \div n$. The value of n may be found by experiment, or, if the aggregating impulses are homogeneous, it may be easily calculated, as will be subsequently shown (V–VII).

II. If the pressure is varying, and so exerted as to produce radial motion, directly towards the centre, the velocity acquired, at any given distance ρ, may be found by the equation $v_\rho = \left\{\frac{2\,fr(r-\rho)}{\rho}\right\}^{\frac{1}{2}}$. Therefore, if the theory of Boscovich were true, at the centre, where $\rho = 0$, v_ρ would be infinite.

III. If the varying pressure, or pull, leads to perpetual radial oscillations, synchronous with perpetual circular oscillations under constant pressure, or pull, the extent of the radial excursions from the centre is $2r$, and the mean velocity of radial oscillation (Postulate 14) is $\frac{2}{\pi}\sqrt{fr}$. The equation $\frac{2}{\pi}\sqrt{fr} = \left\{\frac{fr\,(2r-\rho)}{\rho}\right\}^{\frac{1}{2}}$* gives $\rho = \frac{2\pi^2 r}{\pi^2+4} = 1.4232r$.

IV. Since the *vis viva* of a moving particle varies as $\frac{1}{r}$, the *vis viva* at the radius of average radial velocity in a rectilinear orbit, : the *vis viva* at the radius of synchronous circular velocity : : 1 : 1.4232.

V. If the constrained synchronous rotation of particles in a spheroid, and the free revolution of exterior particles, are due to the same primitive æthereal impulses (I), the uniform velocity of those impulses is the *limiting* velocity, towards which both motions tend when their circular paths are indefinitely diminished. Let, therefore, $v_1 = \sqrt{fr} \propto \sqrt{\frac{1}{r}}$ = velocity of free equatorial revolution; $v_2 = \frac{\sqrt{fr}}{n} \propto \frac{1}{r}$ = constrained velocity at the same point = velocity of superficial equatorial rotation. Then $v_0 = \left[v_1\right] = \left[v_2\right] = nv_1 = n^2 v_2 = n\sqrt{fr}$ = limiting tangential velocity, both of revolution and of rotation, under a reduction of spheroidal volume to an equatorial radius $\frac{r}{n^2}$. Under such reduction, all the particles in the equatorial plane would have the velocity of free revolution, or of perfect fluidity.

*Since $f \propto \frac{1}{r^2}$, the substitution of $2r$ for r_0 gives $fr\,(2r-\rho) = 2f_0 r_0 (r_0 - \rho)$.

Digitized by Google

VI. If contraction were to go still further, the centrifugal force of rotation would give the nucleal particles orbits of increasing ellipticity. These orbits would finally become infinite, when the average linear motion was equivalent to parabolic perifocal motion; or, in other words, when the mean linear velocity, $\frac{2}{\pi}\left[v_2\right] = \left[\sqrt{2fr}\right]$. These velocities tend to or from coincidence at $\frac{2r}{n^2\pi^2}$; for $\frac{n^2\pi^2}{2} \times \frac{2}{\pi} \times \frac{\sqrt{fr}}{n} = \frac{n\pi}{\sqrt{2}}\sqrt{2fr} = n\pi\sqrt{fr}$. We thus find that the limiting velocity between complete dissociation and incipient aggregation ($n\pi\sqrt{fr}$), is $\pi \times$ the limiting velocity between complete aggregation and incipient dissociation ($n\sqrt{fr}$; see V.)

VII. Let t = time of describing $\frac{1}{2}r$, in virtual approach to the centre, under the action of any central force f, = time of describing r in circular revolution, or motion under constant pressure. Then $ft = \sqrt{fr}$; πt = time of free semi-circular oscillation; $n\pi t$ = time of constrained semi-circular oscillation = time of semi-rotation; $n\pi ft = n\pi\sqrt{fr}$ = velocity acquired in the time of semi-rotation = *radial limiting* velocity (V, VI). Therefore the velocity of any central impulses which are capable of producing aggregation, free revolution, and constrained rotation = velocity produced by constant equatorial pressure acting for one half-rotation.

VIII. Radial oscillations, through a radius $\rho = mr$, give the central dissociating velocity $\left(\sqrt{2fr}\right)$ at $\frac{mr}{m+1}$.

IX. Undulations in elastic media tend to generate other undulations, in arithmetic, geometric, harmonic and other figurate progressions.

X. The limiting radius of free revolution (or the atmospheric radius in nebular condensation) varies as $t^{\frac{2}{3}}$; the limiting radius of constrained rotation (or the nucleal radius) varies at $t^{\frac{1}{2}}$. Therefore the nucleal radius $\propto \frac{3}{4}$ power of the atmospheric radius. In ordinary discussions of the nebular hypothesis, planetary aggregation has been regarded as atmospheric, under a velocity varying as $\sqrt{\frac{1}{r}}$; but there are many traceable evidences of simultaneous nucleal activity, under a velocity varying as $\frac{1}{r}$.

ILLUSTRATIONS.

Electrodynamics and thermodynamics furnish numerous illustrations of Prop. I, but some of its most obvious exemplifications are found in cosmical revolution, atmospheric elasticity, axial rotation, and in the various applications of Ferrel's laws.

Proposition II identifies all central forces, so far as an identical ideal limit of velocity is concerned. It is true that the ideal limit is physically unattainable, but a full development of Peirce's theory, of *vis viva* and simul-

Digitized by Google

taneous rotation and transmission,* will doubtless contribute to the proper determination of data for finding the practicable equivalent, in any given case.

According to the dynamical theory of gases, the average radial velocity, which is found by Prop. III, is the velocity which represents constancy of volume, in any aggregation of a homogeneous elastic fluid.

We have already seen (I) that *dynamic* constancy of pressure produces the velocity of circular revolution; and by the principles of thermodynamics, specific heat varies as *vis viva*. Prop. IV, therefore, furnishes an exact mathematical accordance with the empirical ratio between heat of constant volume and heat of constant pressure,† the representative of constant pressure in a perpetual radial oscillation, being the radius of mean excursion; the representative of constant volume, the radius of mean velocity; while the *vires vivæ*, of circular revolution due to constant pressure and of circular revolution maintaining constant volume, are inversely as their respective radii. Newcomb showed‡ that if there is actual collision of particles, they can neither be perfectly hard and spherical, nor hard and not spherical. There must, therefore, be elasticity or something analogous to elasticity, either in the gaseous particles themselves, or in their relative motions. Peirce's views, together with the fact that *vis viva* varies as the quantity of motion, (the quantity of motion, in perpetual oscillation under uniform resistance, being proportional to the average velocity), seem to involve the probability that there is no absolute collision, but the phenomena are due to simple motions, and are independent of the nature of the particles themselves. The *vis viva* of constant circular velocity varying inversely as radius, the product of such *vis viva* by radius, for any given central force, is a constant quantity.§

Prop. V may perhaps prove suggestive, in the study of the mechanical differences between fluidity and solidity, and of the laws of chemical combination, as well as in the elucidation of the nebular hypothesis, of which some illustrations are given below. I have already shown‖ that Alexander's planetary ratio, 1.8, which is the $\frac{5}{3}$ power of the thermodynamic ratio 1.4232, appears in the explosive energy of H_2O, and that this energy is directly traceable to the limiting velocity of synchronous rotation and revolution¶ under the same primitive impulses (I, III).

If the central force f, in Prop. VI, is solar gravity, the limiting velocity $(n \pi \sqrt{fr})$ of uniform impulses which account for solar and planetary

* *loc. cit.*, Feb. 4, 1851.

† The principal estimates of $\frac{c}{c'}$ are: Guthrie, Regnault, 1.41; Masson, 1.419; Tyndall, 1.421.

‡ *loc. cit.*, 1861.

§ The various *vires vivæ* considered in the present paper are:

$v.\ v.$ of interior nucleal rotation in an unchanging nucleus, varying as r^2;

$v.\ v.$ at any point within a homogeneously expanding or contracting nucleus, varying inversely as r^2;

$v.\ v.$ of free revolution communicable by interior nucleal rotation in an unvarying nucleus, varying as r;

$v.\ v.$ of free revolution due to fall towards, or repulsion from centre, varying inversely as r.

‖ Proc. S. P. A., xii, 394.

¶ Ib., and xiii, 142.

Digitized by Google

aggregation, solar rotation, and planetary revolution, is *the velocity of light.** For, Sun's distance from Earth being 214.86 solar radii, the velocity of light $= \frac{214.86r}{497.825} = .4316r$ per second. Equating this value with $n \pi \sqrt{fr}$ and substituting the value of $\sqrt{fr} = \sqrt{gr} = 2 \pi r \times 214.86 \div (365.2564 \times 86400) = .000627049r$ per second, we find $n = 219.0894$, and $v_2 = \frac{\sqrt{fr}}{n} = .0000028622\, r$ per second. On comparing this result with the estimates from observation of Sun-spots, we find it is about $\frac{3}{8}$ of one per cent. greater than Schwabe's estimate (.0000028511), while it is about $\frac{1}{4}$ of one per cent. less than the average of Spörer's greatest (.0000029533, in lat. 1° 45′) and least estimates (.0000027863, in lat. 24° 38′). All other estimates are embraced within Spörer's limits, and most of them agree very nearly with Schwabe's. Such closeness of exemplification in gravitating action, may well encourage a search for others in chemical association and dissociation.

Inasmuch as Prop. VII is a corollary of Prop. VI, it may be practically illustrated by the same examples. It has, however, an additional interest, by showing that the radial impulses continue their efficiency, within the rotating mass, until they are able to proceed, without interruption, in the same direction in which they entered the system. It also lends confirmation to the above values of n and v_2.

Prop. VIII accounts for the coefficients of planetary distances, in the abscissas of my Stellar-solar parabola† of which I offer a new form in my remarks on Prop. X.

The various planetary harmonies which have been pointed out by Titius, Bode, Alexander, Peirce, Kirkwood, and myself, furnish abundant *a posteriori* corroboration of Prop. IX.

Obermayer's Law (Trans. Vienna Acad.; quoted in *Nature*, June 1, 1876, p. 119), that the friction-coefficient of permanent gases varies as the $\frac{3}{4}$ power of the coercible gases and as the absolute temperature, seems to fall under Prop. X, as a particular case of the nucleal and dissociating influences of central force. The planets furnish various other cases, under the same proposition, illustrating Peirce's views as to the constancy of the quantity of motion, or *vis viva*, in a system, Oliver's æsthetic theorem, my planetary pendulums,‡ and nearly all of the postulates.

The time of terrestrial rotation being 86400 seconds, and the time of free revolution at the equator $(2 \pi r \div \sqrt{gr})$ 5074 seconds, the *vis viva* of revolution is $\left\{\frac{86400}{5074}\right\}^2 = 289.68$ times the *v. v.* of rotation at the same point. If this is the *v. v.* at the limit between complete aggregation and incipient dissociation, the *v. v.* at the limit between complete dissociation and incipient aggregation (VI, VII,) is π^2 times as great. Therefore, if Earth's

* Ib. xi, 103, and subsequent papers.
† Ib., xii, 523.
‡ Proc. Soc. Phil. Amer., xiv, 612, 622, sq.

motions represent *nucleal* formative force, the velocity of rotation at the latter point should be $\frac{1}{\pi^2} \times \frac{1}{289.68} \times \frac{2\pi r}{5074} = .0000004331r$ per second.

We have already seen (V) that the solar equatorial velocity at the lower limit is $\frac{1}{\pi}$ the velocity of light, or $.1374r$. But in perpetual nucleal rotation the communicable interior *v. v.* varies as the velocity, or as radius, and in circular revolution the mass $\propto$ *v. v.* $\times r$. Therefore if we refer the solar and terrestrial motions to the same nucleal radius, we get, for their respective masses, the proportion; Sun : Earth : : .1374 : .0000004331 : : 317,500 : 1. This represents a solar parallax of 8″.924 and a distance of 91,600,000 miles.

Applying a similar test to Jupiter's motions, we find no evidence of nucleal formative action, but a close approximation to atmospheric force synchronous with the Earth-aggregating nucleal force.* The identity of value in the two forces may be shown as follows:

The velocity of revolution, at Sun's equator, is $\frac{2\pi \times 91,600,000}{214.86 \times 10020.24} =$ 267.3265 miles per second. If this is the fundamental formative velocity for Earth and Jupiter, Earth's time of semi-rotation (VII) should be $\frac{267.3265 \times 5280}{32.08} = 43998.86$ sec.; and Jupiter's, $\frac{11.08^2}{302.98} \times 43998.86 =$ 17826 sec.; representing a Terrestrial day of 24 h. 26 m. 37.72 sec., and a Jovian day of 9 h. 54 m. 12 sec. Earth's rotation-velocity, therefore, appears to have been accelerated about 2 per cent., and Jupiter's retarded about $\frac{1}{3}$ of 1 per cent. (according to Herschel's estimate of 9 h. 56 m.), since the "Beginning," when the Creative Word simultaneously established their nucleal foundations. Similar relations would hold if the Jovian and Telluric rings were formed at the same time, and the terrestrial nucleus did not appear till the inner ring had been slightly condensed.

If we assume Earth's present limiting velocity (VII) as the indicator of aggregating force, we have $n \pi \sqrt{fr} = 43200 \times 32.08$ ft. $= 262.47$ m. per sec. The solar modulus of light,† at the principal centre of gravity of our system (*c. g.* ☉ and ♃), is 505400 solar radii. Therefore the nucleal-formative $v = \sqrt{505400} \times$ the atmospheric v, and when the nucleal v was the v of light ($.4316r$), the atmospheric $v = .0006071r = 262.47$ m. This would make Sun's distance ($214.86r$) $= 92,891,300$ m.

Since the velocity of primitive nucleal rotation varied within the nucleus as r, communicating a similarly varying *vis viva* to the shrinking nucleus, the above indicator gives, as the theoretical time of solar rotation, $365.256 \div \sqrt{214.56} = 24.912$dy., which implies an equatorial velocity of $.0000029192r$ per sec. Astronomical observations, and Props. VI, VII, and X, therefore,

*Hence, perhaps, the similar density of Sun and Jupiter.

†$v = \sqrt{2fr}$; $\therefore r$, or *modulus*, $= v^2 \div 2f$. This involves Alexander's postulate of æthereal inertia.

Digitized by Google

furnish the following approximations to the rotation velocity, the unit being one ten-billionth of Sun's radius:

Spörer, maximum.	Nebular action.	Light action.	Schwabe.	Spörer, minim.
29533	29192	28622	28511	27863

According to the same indicator, the present height of possible solar atmosphere, or the radius of equal centripetal and centrifugal solar force should be $(214.86)^{\frac{2}{3}} r = 35.873\, r$; the time of planetary revolution at Sun, $1yr \div (214.86)^{\frac{3}{2}} = 10020.242$ sec.; the present limit to the velocity of constant pressure, $2\pi r \div 10020.242 = .000627049\, r$ per s; the present solar modulus of light, $(.4316 \div .000627049)^2 r = 473755.65\, r$; the present modulus atmosphere, $35.873 \times 473755.65 = 16995141 r$.

If we locate the Stellar-solar paraboloid by a vertex at $\frac{1}{\pi}$ solar radius, (the primitive locus of complete association), and an abscissa ($x_{35\cdot873} = 35.873 \times$ modulus) at the present surface of modulus-atmosphere, the general equation, $x_n = \xi\, \eta^{\pm n}\, \zeta^{n^2}$, furnishes 9 abscissas between Sun and Mercury, and 9 between Neptune and *a* Centauri, the central 9 representing points of dissociating planetary velocity (VIII), as will be seen by the following table of secular elements:

n	Log.	x_n	Perihelion.	Mean.	Aphelion.
9.873	$\frac{3}{4}$ ☿	1.6774	1.6806	1.7950	1.8855
10.873	$\frac{1}{2}$ ♀	1.9099	1.8586	1.8905	1.9200
11.873	$\frac{2}{3}$ ⊕	2.1541	2.1256	2.1561	2.1845
12.873	$\frac{3}{4}$ ♂	2.4102	2.3248	2 3901	2.4468
13.873	$\frac{4}{5}$ Ast.	2.6779			
14.873	$\frac{5}{6}$ ♃	2.9575	2.9420	2.9692	2.9949
15.873	$\frac{6}{7}$ ♄	3.2488	3.2064	3.2447	3.2799
16.873	$\frac{7}{8}$ ♅	3.5519	3.5217	3.5571	3.5897
17.873	$\frac{8}{7}$ ♆	3.8668	3.8614	3.8678	3.8740
36.873	*a* Cen.	7.6622	7.6571		7.6860

The tabular logarithms for *a* Centauri (7.6571 and 7.6860) represent, respectively, the least and greatest estimates of its distance that have been made. The values of the secular planetary perihelia and aphelia are taken from Stockwell's "Memoir on the Secular Variations of the Elements of the Orbits of the Eight Principal Planets" (Smithsonian Contributions, 232, pp. 37, 38).

It is of course impossible, under the present limitations of our knowledge, to determine to what slight extent the foregoing calculations should be modified, by allowances for orbital eccentricity and other considerations. It seems likely, however, that the parabolic abscissas (X) are the fittest representatives of primitive nebular condensation and retardation, while the forces of constant pressure within the primitive nucleus furnish the closest approximation to the ultimate light-activity. If this opinion should

Digitized by Google

be confirmed by the discussions of the late transit of Venus, the accuracy of my chemical estimate of Sun's mass and distance* will be likewise confirmed.

The generalization of Faraday, as corroborated by the measurements of Weber, Kohlrausch, and Clerk Maxwell, is thus extended to include gravitation, as well as electrostatic and electrodynamic action, in the same category of central force with light (VI), by means of an identical limiting *vis viva*. The simple mathematical correlations make the generalization still broader, so as to embrace heat (IV), chemism, cosmical and molecular aggregation, dissociation, rotation and revolution (V–X), and all central forces (I–X).

The Flow of Water Through an Opening in a Pierced Plate.

By Robert Briggs.

(*Read before the American Philosophical Society, November 3d,* 1876.)

The consideration of the subject of the *vena contracta*, or section of a vein of water emerging from an orifice under certain conditions, is made a portion of the proceedings of the Philosophical Society of Glasgow, and appears in their volume X, page 145 et seq. Four papers are published, the first of which is an extract from a letter of William Froude, Esq., C. E., F. R. S., to Sir William Thomson, dated Cheston Cross, Torquay, 20th December, 1875. Mr. Froude is quoted† * * * * "One result I have tried came out well :—The discharge through an introverted cylinder [tube] with keen edge. Here, by theory, the section of the jet ought to be exactly half of the aperture. For the conservation of stream line energy obliges the velocity to be that due to the head, while the conservation of momentum requires that the pressure on the aperture (which is here the sole operative pressure setting in the ultimate direction of the velocity generated) is only sufficient to create as much momentum, say, per second as will be resident in the length delivered per second, of a column of discharge, of half the sectional area of the aperture, if its velocity is that due to the head.

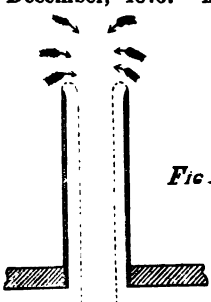


Fig 1

"The cylinder was quite smooth outside and the edge quite keen. The area ratio came out 0.503, 0.502, &c., instead of 0.500, and the little excess was obliterated, if the head was counted, to about one-fourth the diameter below the edge ; as indeed it ought to be (I won't swear to the exact figure

* Proc. S. P. A., xii, xiii, *loc. cit.*

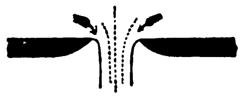
† The entire article is quoted, the hiatus indicated by asterisks exist in the published Proceedings of the Glasgow Society.

Digitized by Google

one-fourth), because till the motion of the particles is purely parallel to the axis, there must be some accelleration to be effected in the direction of the axis, and this demands the employment of some vertical pressure. * *

"In the *vena contracta* experiment with the thin plates and open air between the plates, the fluid was welcome, if it pleased, to start tangentially to the plane of the aperture as here indicated, and as it appears to do if closely studied. So also with the introverted cylinder; although it was not possible to see what happened I have no doubt that the motion of the particles *next* the edge was vertical upwards, the curvature being only such as the pressure in the contiguous stream would satisfy. If the experiment was not adroitly initiated, the water seized the inner surfaces of the cylinder and run out in an eddied condition, filling the discharge pipe. When, however, it was properly started, the contracted column below issued with beautiful smoothness and symmetry."

Fig 2



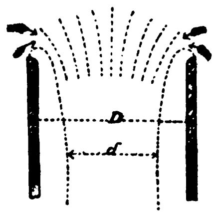


Fig 3

The second paper on the subject is an extract from a letter of Sir Isaac Newton to Professor Cotes, March 24th, 1710–11; from the "*Correspondence of Sir Isaac Newton and Professor Cotes, including Letters from other eminent men,*" published in 1850, by Mr. J. Eddlestone, Fellow of Trinity College, Cambridge, from the originals in the Library of Trinity College. This letter possesses much value as showing Newton's experiment and discussions of the form of the *vena contracta*, and will be found interesting to examine in the proceedings of the Glasgow Society by those who have not ready access to the primary publication. Newton found the *vena contracta* from an aperture in the *side* of a vessel of thin sheet tin plate, five-eighths of an inch in diameter, to have, at the distance of one-half an inch from the hole, a diameter of 21-40ths of an inch. Which was a reduction of diameter of 21-25ths, and of areas of cross section of 0.7058.

A foot note to this letter of Newton by Mr. Eddlestone says, that '*Sectio vena contracta*' was a term used by Jurin, Philosoph. Trans., Sept.—Octo. 1722, p. 185; and that Dan. Bernouilli uses the same term, Hydrodynam., p. 65. Jurin also uses '*vena contracta*'; in all these cases the words denote the reduced section only, while subsequent usage generally applies them to the stream itself as a body, between the orifice and the point of reduced section.

The third paper is a discussion of the *vena contracta* by Professor James Thomson, LL.D., C. E., University of Glasgow, and is a mathematical discussion with six illustrations, intended to demonstrate under certain conditions, as for instance the supposed absence of fluid friction or viscosity, and a supposed great magnitude of vessel and depth of water compared with the dimensions of the orifice, that the jet of water issuing from an

Digitized by Google

orifice in a thin plate, from a conical adjutage either protruding or re-entrant, has a section, where the stream flows out in sensibly parallel lines, of *more* than half the area of the orifice, and that this condition only ceases for a re-entrant nozzle, in the form of a parallel tube as treated of in Mr. Froude's paper. The conclusions of Professer Thomson do not seem to the writer as warranted by the conditions to which he limits his proposition. The value of the assumed force which he denotes by P is by no means satisfactorily exhibited. As the purpose of this paper is to discuss other points, further notice of Professor Thomson's article may be omitted, only it will be assumed that the reader of this refers to the Glasgow Society's proceedings to see for himself what is set forth by the Professor.

The fourth paper is an abstract of remarks by R. D. Napier, Esq., who gave some consideration of this subject, which was published in 1866, in a pamphlet "*On the Velocity of Steam, &c.*," in which he made the general assertion, with some qualifications, that the area of the true theoretical *vena contracta* is half that of the orifice. He says, "I have proved in the pamphlet referred to, that the pressure in the plane of the orifice is nearly half the pressure due to the head, and that from thence to the *vena contracta* [the words are here used in the sense of the section of least area] it gradually diminishes to zero. This diminishing pressure causes increasing velocity, and is thus the direct cause of the *vena contracta*. * * * "About three-eighths of the ultimate velocity and five-eighths of the *vis viva* is imparted to the water outside of the plane of the orifice, and it is absurd to attribute these effects either to what I may call the converging momentum being transferred from one side of the orifice to the other, or to the converging particles preventing the free egress of the stream through the orifice, which are the only views hitherto offered to explain the cause of the *vena contracta*."

This question of the *vena contracta* is a very pretty one in physics, and deserves a more complete and general discussion than it receives in the pages of the Glasgow Society. It should be recognized however, that it does not admit of the simplicity of investigation, either mathematically or experimentally, which the papers of Mr. Froude and Professor Thomson assume. It is impossible to divest the consideration from the fluid friction against the contiguous sides, surfaces, or the edges of the aperture, nor from the fluid friction of the liquid within itself which constitutes *viscosity;* nor yet further, from the frictional resistance to discharge into another medium (the atmosphere in this case); while the absolute strength of water is brought into action in the emerging column to the extent of pressure of the atmosphere. Values for these various elements can be accepted, and the mathematical investigation proceeding from them, would enable a thorough solution of the problem, in place of the extremely partial one essayed in the proceedings of the Glasgow Philo. Soc. Even the effect of dimension of vessel or volume of water with relation to the aperture might be made a part of the investigation and appear in the result.

In such an attempt to find a general solution of the theorem it would at

Digitized by Google

once become evident, that there are two normal forms for the *vena contracta*, viz.: That, when the stream emerges *downwards* from an opening through horizontal edges, and that, where it emerges *upwards* through an opening of the same character. The first of these gives a pencil, whose shape for its longitudinal section at its upper end, or origin, will be controlled by the nature of the aperture, and by the effect of the initial directions of the particles of the effluent liquid (the theoretical *vena contracta, under pressure, but devoid of gravity*); modified by the effect of gravity, which would give to any descending pencil of a fluid, the motion of whose particles shall be established in approximately parallel lines, a hyperloid contour. The second of these will give a sheaf, whose shape at the point of efflux, will be determined by the same laws; while it would now be modified at this point, by the *load* of the emerging fountain, and at the same time the form of the stream above (in this case attaining on some plane an absolutely contracted section), would be that of a hyperboloid sheaf, with both *external* and *internal* lines of definition. If it be supposed in this second instance that the plane of efflux (of the orifice) is slightly deviated from the horizontal, so that the emerging stream is made to take a line out of the perpendicular one, the sheaf form would be disturbed; and at some quite small angle of deviation, a trajectory curve would take its place.

The general course of the stream would then have a modified parabolic curvature—a trajectory curve, which has been frequently discussed—but the exact contour of the pencil is still an open question. It is certain than when passing the point of greatest elevation, it would have, from its retarded motion, its greatest cross-section, and that this cross-section would be a flat oval of peculiar form; and it is probable that beyond this section, on the descending stream, it would become nodal, for the same reasons that a stream emerging from any orifice except a circular one becomes nodal.* In short the complete solution of the problem not only admits and assumes values for all the physical conditions, but it will embrace all directions of efflux from 0° to 180°, where 0° may be taken as the perpendicular direction, either upwards or downwards.

It is possible, for the purpose of illustration, to give some consideration of the *vena contracta* upon hypotheses similar to those of Professor Thomson, and if other conditions are assumed at the same time, an *appreciation* of the phenomenon can be had. In truth the view it is proposed to offer may go further than a mere appreciation, and may be made the basis for support of the other fundamental controlling conditions, and indicate the true line of procedure for mathematical investigation. Let us suppose, with Professor Thomson, that the effect of fluid friction, or viscosity, is neglected; that the magnitude of the vessel and the depth of liquid, is so large in relation to the dimensions of the orifice, that no appreciable velocity is imparted to the mass of liquid by the discharge; that the jet is one issuing downwards (so as to have the cross-section under absolutely uni-

* See article by Weisbach, "Ausfluss," in the "Allgemeine Maschinen Encyclopädie."

Digitized by Google

form pressure); that the orifice is a circular hole in a thin plate—the flat bottom plate of the vessel—and that the effect of gravity on the stream after emergence be neglected, as well as the atmospheric resistance and the acceleration due to the column of discharge, in the production of a vacuum upon the sectional area; and the following sketch (Fig. 4) gives a general ideal view of the *vena contracta* under these suppositions.

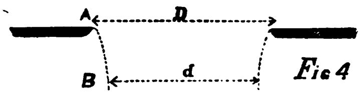


Fig 4

Weisbach* has observed that the actual diameter = d of the vein of emergence from a thin plate, is about 0.8 D; at the point B, which will be found from one-fourth to one-half the diameter (= D) from the plate; and this is accompanied with an efflux, as measured by the quantity of water discharged, of = 0.97v, where v = the velocity of flow = $\sqrt{2gh}$. Now it is an obvious conclusion that at any point on the surface of the *vena contracta* between A, the edges of the plate, and B, the point of minimum section, a particle of water must be in such equilibrium of pressure as to establish its direction of flow, or in other words its curved path; when it becomes apparent that some momentum must have been imparted to such a particle, to induce it to follow in its line of trajectory, instead of following the direction due to gravity, or to the application of the pressure normal to the head, or column of water above it. An attachment to the orifice can be constructed which will exhibit this phenomenon, or rather provide for its occurrence as a matter of necessity, as follows: Let there be an opening in a thin plate as before (Fig. 5), and let this opening be *guarded* or protected by a disc (Z) of the same diameter, = D, let this disc be placed so that its edges (C C) shall be one-eighth the diameter = $\frac{1}{8}$ D (C A) removed from the hole. On these suppositions, if the diameter of the section of least area, = d, be taken at 0.707 D, then the area of the peripheral opening (at C A) will be equal to the area on the plane of (B). The line of effluent stream (A B) may be imagined to be a quadrant of a circle, which will then have of course, a radius, = 0.147 D. Now let the face of the disc Z be made a conoid, so that the areas of the surfaces of the conical frustra a b c d e shall be equal, or in other words, so that all the sections normal to the curve A B shall be equal.

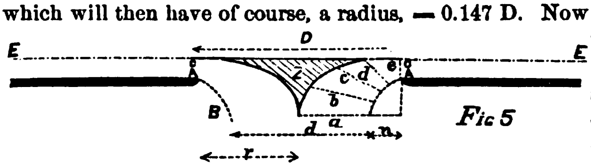


Fig 5

[The co-ordinates for this curve of the face of the conoid Z, in terms of x and y, where x is supposed to have its origin at point of the prolongation of the line CA on the line B; are given by the equation:

$$y = \frac{\sqrt{[r^2 + n^2 \pm \sqrt{(r^2 + n^2)^2 - 4\,n^2x\,(2r - x)}] - 4(r-x)^2(r+x)^2}}{2(2r - x)}$$

* Weisbach's Mechanics.

Digitized by Google

In this equation r = the radius of the opening commencing at the origin of x, and n = the radius of the quadrant or corner commencing at the same point.

The assumption of the quadrant of a circle for the path of the effluent particle from A to B, has been made in order to give a simple equation for, and ready comprehension of, the nature of the sections of the stream normal to its face on A B where, by equalities of areas, uniform velocities would subsist; but the real curvature (A B) is obviously parabolic, and the plane of B is infinitely distant from (below) the plane of A. Observation has shown, that at about one-fourth D below the plane of A the least section of *vena contracta* is apparently reached, and that below this plane of section, the pencil of descending current has its sides with only so much divergence from parallelism, as is due, almost entirely, to the acceleration of the falling stream. An elliptical quadrant which shall approximate to the true parabolic curve can be readily substituted by construction (or calculation) for the quadrant of a circle, in the equation above quoted, and the new values for y, will give loci for the curve of the face of the conoid Z to correspond to the substitution. The value of the radius of the minor axis on the line B as determined by observation, may be taken as that of (n) in the equation. By this method a very close approximation towards the true form may be attained.]

It will then result that the efflux from the peripheral opening C A inwards, having any given velocity, will, in every part of the current, until the least section of the *vena contracta* on the plane B is reached have a uniform and constant rate of speed; neither acceleration, nor transformation of head into velocity, will have occurred in the change of direction. If the consideration of the fluid friction, etc., be not taken into the question, and the velocity of efflux at C A is that due to the head, that at B is established and maintained; whence any liquid particle on the surface A B must be in equilibrium of pressure, both from head or momentum in direction of its flow, *in which direction the entire head is transformed into velocity.* The plate, or plane surface of D, may be imagined to extend indefinitely in the directions, E E, in which case the velocity of flow of liquid, interposed between the plate E and the bottom A, will decrease as the radial distances from the edge of the aperture; in inverse ratios of the radius r to any new radii $r_{\prime}$ $r_{\prime\prime}$ $r_{\prime\prime\prime}$: while the height, of liquid column corresponding to the several velocities, = V at r, $V_{\prime\prime}$ at $r_{\prime}$, will vary as $\left[\frac{r}{r}\right]^2 : \left[\frac{r}{r_{\prime}}\right]^2 : \left[\frac{r}{r_{\prime\prime}}\right]^2$ &c. The pressure or total height is supposed to have been completely transformed into velocity, = V, at the peripheral opening C A, and the stream or sheet of fluid would exert no transverse pressure at C A, either upwards or downwards; while the transverse fluid pressure on the supposed plate or the bottom of the vessel would vary as $\left[\frac{r}{r}\right]^2$ (at C A) to $\left[\left[\frac{r}{r}\right]^2 - \left[\frac{r}{r_n}\right]^2\right]$; r_n being any assumed radial distance from the centre of the opening. Thus if the radius r be taken as

one-half inch, and that of r_n as five inches (or ten times r), the velocity of flow towards the aperture at r_{10} would be only one tenth of that at r; the head required to produce the velocity at r_{10} would only be one-one-hundredth of that corresponding to the velocity at r; and the pressure of the head remaining on the plate or bottom at r_{10}, would be ninety-nine-one-hundredths of the total head.

These two pressures on the plate and the bottom would be equal and opposite pressures, and if the plate were removed, the unbalanced pressure on the bottom would represent the force P, to which Professor Thomson gives an undefined value. Its total, is of course the sum of the head upon the area of half the opening, and continuing the supposition of removal of the plate, it is encountered and balanced by the *momentum of the descending mass*, so that the bottom would now be in equilibrium of pressure, and the force P, as an unbalanced one, would disappear.

Returning to the examination of the proposition as shown in Fig. 5: the static resistance of the under surface of the conoid Z in a vertical direction against the flow of water in its radial movement towards the centre of the orifice, and while following the path of the under surface of the conoid, is represented in total by the divergence at right angles of the entire effluent stream; = to ½ D of superfice, under the head which has produced the efflux. The reaction of the flow of liquid downwards is also equal to another statical resistance of the same value, and in the same direction; and as the total pressure on the conoid Z from above, is its entire upper surface, under the head of liquid above it; the one pressure above balances the two pressures below, and the conoid itself is in equilibrium.

If it is now assumed that there exists no frictional adhesion of the liquid to the surfaces of the supposed plate, and of the bottom of the vessel, and the vessel is of indefinite extent, so that the velocity of entry at E E is reduced to an inappreciable rate of flow, then the condition of the formation of a perfect *vena contracta* will have been exhibited. The removal of the guide plate E E, and the removal of the bottom of the vessel, and substitution of a re-entrant tube, would replace the supposed frictionless surfaces by liquid mass, which if it is still continued to be supposed devoid of *viscosity*, would enter the peripheral surface C A with the same force, and in the same direction, and would still preserve the same perfect *vena contracta*. The removal of the conoid Z would provide a fluid conoid of the same shape, *or a distribution of internal strains* productive of the same resistance, and (still assuming the perfect liquid) the same perfect *vena contracta* would follow. If however there is admitted to exist a certain adhesion to the bottom of the vessel, or to the surface or edges A A so that the velocity of a particle on A B is less than that fully due to the head; the surface (d) would then become larger than ½ D, the dimension C A would be properly increased to give the corresponding area of efflux, and the conoid Z would also have such a contour as would permit the uniformity of flow of each and every particle of the liquid at unchanged velocity, in any section of the *vena contracta* transverse to the direction of the flow. This increase

Digitized by Google

of dimension of the cross section *d*, and the effect of the descending pencil in accelerating the flow through it, can be taken as sufficient to account for Weisbach's observed value of = 0.8D, and position of least section at = ½ D, as has been before quoted.

It must not be taken for granted that the writer is arguing that the conoid Z actually exists in the water, but it is here assumed for the purpose of showing that all the phenomena of the *vena contracta* are consistent with the supposition. Mr. Froude's "*tangential*" direction for the fluid in Fig. 2, which he says appears if closely studied, is a portion of the proposition, and this discussion exhibits "the imparting of velocity and *vis viva* outside of the plane of the orifice," as alluded to by Mr. Napier

There is one other point worthy of notice in this radial flow of currents towards an orifice, and the radial direction at the edges of the opening. With or without the assumed central, neutral conoid, this flow is in exceedingly unstable equilibrium, especially when in contact with a bottom plate, (the friction or adhesion to which retards the flow), the radial direction may be diverted to a small extent, so that the particle of water where it curves at the point A, or at any other point on the line C A may possess absolute momentum out of the line towards the central axis of the pencil.

The radius of the opening calls for a very slight deviation of entering horizontal current, when its dimension is compared to the area from which this current is derived ; and there is really but the slightest cause for the currents to direct themselves to the exact centre of the orifice. In point of fact the permanency of the *vena contracta* of downward discharge is derived in great degree from the pressure of the atmosphere, which is brought into action, by the descending pencil below it. The effect of a tangential afflux at the peripheral circle C A is to give a rotation to the pencil, which at once accelerates, to some limit of discharge, and obliterates the *vena contracta* The motion of the particles will yet remain limited *in any direction* by the head, but as the stream emerges with a rotary motion, the path of any particle becomes a spiral one, and the whole pencil advances, or is discharged, at a slower rate than is due to the particle velocity. In the case of the re-entrant tube, where the pencil is divested from the effect of gravity, by exhaustion of the air by the effluent stream passing from the tube, it is very difficult to get a *vena contracta*, as Mr. Froude testifies. This action of the tangential afflux is not confined to the emerging stream, but shows itself in the vessel as well, where a whirl is established which involves the entire mass of water enclosed. In the case where the bottom of the vessel has a funnel shape, this whirl sets up with great vehemence, and the centrifugal force of the established current may be sufficient, under favorable circumstances of form, head and dimension of vessel, to displace the entire central portion of the liquid, and the pencil of emergence will become a tube, whose core will be filled by an induced current of air. These phenomena of efflux are only noticed to embrace in my remarks some of the influences which effect the *vena contracta* where the conditions of formation are varied by adjutages, and to make it evi-

Digitized by Google

dent that neither the study of phenomenal nor the mathematical considerations involved, have been exhausted in the papers of the Glasgow Philosophical Society, while the present article does not pretend to do more than to indicate the direction in which enquiry should be pursued.

Remarks upon the Tónkawa Language.

By Alb. S. Gatschet.

(*Read before the American Philosophical Society, Nov.* 17, 1876.)

A small body of Texas Indians, the wretched remains of a once powerful tribe, bears the name of *Tónkawas* or *Tónkaways*, and is called *Tónkahuas* by Spanish writers. Through the unfortunate homophony of their name, they were frequently confounded with the Central Texan or coast tribe of the Towakonays, who certainly were congeners of the Wichitas and Wacoes, and led a nomadic life in close community with the Karankáhuas, Arrenámus and Caris. A bay in the middle part of the Texan Gulf Coast is called Carancáhua Bay up to this day. At the time when Spanish missionaries, along with a number of their Aztec helpmates, had colonized the South of Texas, and disseminated the germs of the Roman Catholic faith among the untutored tribes of aborigines, whom they induced to join in agricultural pursuits in the vicinity of their missions, the Indians were treated with humanity. Then Mexico and all Spanish America freed itself from the domination of the distant mother country; Texas declared itself independent from Mexico, and when after another lapse of time the Texan settlers proclaimed their adhesion to the American Union, a war of extermination commenced against the helpless Indians, which up to our days continues without abatement on the northern border against the roving bands of the Lipans, Comanches and Kiowas.

The Tonkawa tribe, however, whose first mention in American annals occurs at the commencement of this century, seems to have suffered more from internecine wars and feuds with the Comanches, than from white settlers. In 1847 official documents put down the number of their warriors at 155, a decrease of about two-thirds since 1820. The remnants of the tribe, about 35 warriors with their families, are with a number of Lipan-Apaches at present gathered on a reservation in Shackleford County, Northern Texas, seven miles from Fort Griffin. They raise stock, hunt the buffalo, and serve as scouts on the expeditions of the United States troops stationed at Fort Griffin. They are exceedingly filthy in dress and habits, paint their faces in a grotesque manner, and live in canvas tents. Their national legend represents them to be the offspring of the *wolf;* hence this animal is worshipped in their *wolf-dance*, of which Schoolcraft has given a description (in Vol. V).

Two Bavarian gentlemen have lately visited and studied this obscure and half-forgotten tribe, and have favored me with their notations on the na-

Digitized by Google

tional idiom. One of them, the chemist Oscar Loew, visited in August 1872 that section by order of the "Texas Coal and Copper Mining Association" for metallurgical and mining purposes, and in subsequent years became a very efficient member of Lieut. Geo. M. Wheeler's Surveying Expeditions west of the 100. Meridian. His field-notes on Texas and the Tonkawas have been published in "Petermann's Mittheilungen," Gotha, 1873 (December). The linguistic materials collected by him and Mr. Fr. von Rupprecht were published in full by me in my recent book: "*Zwölf Sprachen aus dem Südwesten Nordamerikas, Weimar* 1876;" and this article here merely contains the results of a closer investigation, hitherto unpublished, of the Tonkawa words and sentences transmitted to me.

Tonkawa differs absolutely in its radicals from all surrounding American tongues, and the few terms coinciding seem to have been *borrowed* from neighboring idioms. Most syllables *begin and terminate* with consonants, but consonants never preponderate in number so as to obscure the pronunciation of the vocalic elements. The consonants composing T. words are as follows:

Explosives: k, g; t, d; p, b; x; tch.
Spirants: s, sh, h, v, y (in English: *yoke*).
Liquids: n, m, l, r.
f does not occur; d and r are scarce, and g very unfrequent.

Among the vowels i, e, a, o, u (all sounds were given here the *Italian* pronunciation), *a* alone is softened into the "Umlaut" ä (ekkvan and ekkvän *dog*) and forms the diphthongs ai and au. No other diphthongs exist but eu, ei, oi; and those formed with y (ya, ye, yo, yu), if we choose to call them diphthongs. As in most of the Northern idioms of America, vowels frequently form a hiatus: e-e-ion *week*, esamó-i *broom-weed*. Combinations of three consonants frequently occur, but they never sound unharmoniously to our ear, and in fact the Tonkawas seem to be endowed with a remarkable sense for linguistic euphony. They lack the softer palatal dsh, and all the aspirates but χ (or kh): the hard guttural occurring in Welsh, in German ("tra*ch*ten") and in Spanish (j in *mujer, dejar*); -s at the end of words generally becomes -sh or -tch, and it alternates throughout with sh. A final -n is exceedingly frequent. The mutes often alternate among each other, b with p, g with h, k and χ (and t with tch).

Redoubling the monosyllabic root is a means of grammatical synthesis extensively used for *various* purposes by all languages known; the T., however, seems to employ it almost only for onomatopoetic purposes, as in: tchatchaya *to laugh*, koχoχua *to breathe, perspire*. tchutchuχ *to be scared*. The nature of the material available does not as yet allow to establish general grammatical laws for the T., but permits a glimpse at its method of compounding words, and gives a few indications of structural import. The system of the object and subject pronouns seems to be rather intricate.

The negative particle *not* consists of two parts, *ka* and *pa*, which are frequently placed one aside of the other, as in Apache, and in Tehua (New-

Digitized by Google

Mexico). But more frequently only one part of it appears as k', ka, g'; b', ba, p', pe—as in: tcheno *to be*, tchapeno *not to be;* ne-enoχ *to know* (?), nek-enoχ *to ignore*, gin'χenu *I do not know* (g is here the negative particle); shai *ka* tu lel *I have no time;* shaya yétsoχanak on *be: I was not in the house.* Where it can be done, the negative particle is incorporated into the stem of the verb as *ba* or *bó:* hé-el yaχa *he eats*, hé-el yaχabó *he does not eat*, χaχaha *I was* or *went*, χaχabaha *I was not* or *did not go. No!* as a negative answer to an inquiry is *aga*, (*a-ka*)!

Kapa, the two particles combined, or *kapai, kapa-i*, evidently has the force of an adjective: "none, nothing": shai aχ kapa yeshik *I have* NO *water;* shai aχuenχa kapa yévuesh *I have no horse.* It is also pronounced *kopei, kopeia*, and in this form occurs as a privative particle in compounds: shenχōn *dress, coat:* sankuon-kopei *naked*, kopeia-veika *poor, indigent* (the root of veika lies in yé-vuesh *to be possessed of*).

The first syllable of the word (ka-, ko-) probably occurs also in a protracted form in ka-a *sick*.

PREFIXES.

A number of *prefixes* can easily be pointed out in T. verbs and nouns, but to find out the real power and original meaning of these prefixed syllables is a difficult task. *He-* is a frequent prefix in nouns and verbs, and is found also in interrogative pronouns and particles as well as in the demonstrative pronoun of the third person singular; hé-el, helatla, *he, himself*.

he-yatchon *eyeglass*, cf. atche *to see*.

he-lepuen *tree, forest*.

he-ntaitchon *tooth*.

he-nshon *blood* cf. ya-tson *heart*.

ha-lonkaiχaχ *knife*, cf. ya-lona *to kill*.

ha-wei, ha-vei *large, big, high, tall*.

he-ktau-e *to sing, chant*.

ha-iχo *to ride on horseback*.

The prefix *ne-* occurs quite often and is used in forming verbs from nouns and nouns from nouns or verbs, as can be inferred from the following examples:

ne-baχka *to smoke*, from baχka, the English word *tobacco*.

ne-shuana *to shoot*, and ne-svon- in the compound nesvon-pillel *round of ammunition*.

ne-vauva *to expire, die*.

ne-k-enoχ *to ignore* (lit. "not-well [know]").

ne-muetan *eye* (root probably in metan *to flash up*).

ni-muetchχon *nose*, derived from the preceding.

ni-kamon *bone*.

ni-steχon *ice*, from teχon *rock, stone*.

ne-shgashan-oyuk *towel*.

The most frequent of all the T. prefixes is undoubtedly *ya-, ye-, yo-*, found in verbs as well as in nouns. In active verbs it seems to fulfill the functions of an object-particle incorporated into the verb, as we see it occur-

Digitized by Google

ring in many Mexican, Southern and Northern languages; in Aztec f.i. the particles *te-*, *tla-*, *tetla-*, are used for this purpose. The nature of this particle is elucidated by the following grammatical juxtapositions:

kala *mouth:* ya-χa *to eat.*

shaya *tchen* vantch *I see thee :* naya ki *ye-tchu thou seest me.*

veika *possessed-of, having* (in : kopeia-veika *indigent*) : shai yé-vuesh *I possess* (aχuenχa *a horse*) : auvash ye-yaχanosh *I eat buffalo-meat* (here the particle occurs twice).

In these sentences the particle *ye-*, connected throughout with transitive verbs, has a reference to the direct object, which either precedes or follows the verb. It is found to occur also in the following transitive verbs : ya-lona *to kill,* yo-χoya *to hunt,* perhaps also in eisatuk *to cut, sever,* if this term is misspelt for ye-satuk.

Some of the following substantive nouns built up with this particle can be distinctly traced to their respective radicals :

yé-tsoχan *house,* originally *tent,* from tsoχ *cloth.*

ye-tsoχe i-tsan *button,* from tsoχ *cloth.*

e-shauké-huen *shirt* (probably instead of ye-tsoké-huen, from tsoχ *cloth*).

ya-χau *spur,* from χaχa *to go* (or to make go?).

ye-koχon *boot,* from kaχa, χaχa *to go.*

ye-keván *entrails, guts,* from kevano *wet.*

ya-teχon *stone, rock,* cf. helepuen-teχek "*mountain-forest.*"

ye-ntan *wind.*

yo-tchan *nail* (on fingers and toes).

ya-tson *heart.*

ye-la *chair, seat.*

e-baχu-eta *woman* (instead of ye-baχu-eta?).

ya-tch-χenon *bread,* from yá-χa *to eat.*

The word for *stone, rock* seems to have two forms : *teχon,* and *ya-teχon,* and the circumstance, that this prefix *ya-,ye -* is generally found in substantives along with the affix *-an, -on, -en,* etc., proves that there exists some connection between the two. Evidently they are the two principal elements used in building up substantives from the monosyllabic roots.

There are many reasons for assuming that *s-, sh-* is a Tonkawa prefix, though it cannot yet be distinctly proved to be such. It occurs in the following pronouns, nouns and verbs :

shaya, shai *I, myself.*

hetet-shá *whereto?*

hetet-sho-olok *what thing?*

shapon *to hide, conceal.*

shoyana to *swim,* cf. esvalan *fish,* aye *to move,* or *live in water.*

soskuono *to hear* cf. χaion (in :-enatch-χaion *ear*).

si , se- is also prefixed to the numerals 4, 6, 7, 8, 9, 10.

A few terms of Loew's vocabulary begin with the syllable *ok-*, which I presume to be rather a generic term than a prefix. Perhaps it means "animal" or "quadruped," for it occurs in okau *skin, fur-skin,* okemeillo

Digitized by Google

hog, swine, okmek *lion*, and probably stands also in the initial syllable of okopák-χōn *hat* (originally made of skins or fur), in : aχuenχa *horse*, and *uk*uen *dog*, which is spelt ekkvan by Mr. von Rupprecht. We have here another instance of the curious fact that the horse and the dog are called by Indians with the same root or word-stem and we would possess many more of these instances, if the horse was not so frequently called by the imported Spanish term kaway, kavâyo. The following table gives an enumeration of the terms for *horse* and for *dog* from various tongues :

Isleta (New Mexico)	ganidá, *horse*	kuyanidá, *dog*.
Natchez	wvskupser	wvskup (v = a short surd ă.)
Yuma-Tonto (Arizona)	χata	tsata.
Dakota	shunktánka	shúnka.
Payute	pung-gú	pung-gúts.
Sahaptin	kússi	kússikussi.
Wintoon (California)	shuku	kanti-shuku.
Klamath	uátch	uatchága

The last-named term *uátch* simply means "living creature, being," and *uatchága* is its diminutive, from *uá to exist, to live, to stay;* applied to our Tonkawa terms composed with *ok-*, this supports the opinion, that *ok* and its compounds have a similar signification of *creature*, or animated *being*.

The Natchez term for *horse* is the augmentative of wăskup *dog*, and as Dr. D. G. Brinton has shown, *wăs* is "apparently a generic term for a certain class of animals," and occurs as *wĕ* in the language of the Uchees or Yuches, which forms a similar series of compounds.

Okemeillo *hog, swine* is really the "beast feeding on the meadow," for hueu-meil means *prairie* or *meadow*.

AFFIXES.

Of a more diversified character than the formative prefixes are the *formative affixes*, that is the syllables *appended* to roots or word-stems, and intended to form derivatives.

We frequently meet f.i. a terminal syllable -i in nouns, which is appended almost only to vowels and often coalesces with them into a diphthong :

shaχe-i *shadow, shade*.	aχaloi *ant*.
esamo-i *broomweed*.	kapai *nothing*.
také-i *head*.	tei-i *liver*.
tsélai *cloud*.	senanda-χas-i *copperhead snake*.

A second derivational affix *-eta* occurs in the words :

nemuetan *eye*.

beχueta, ebaχueta *woman*.

keta-, kete- *friend, partner* (in : ketepanon *my partner*).

Compare this affix with eta *to come* and with the particle heteta? *where?*

A third affix in *-k* (-ak, -ek, -ik, -ok) frequently turns up in substantives, adjectives, and other parts of speech :

kalok *beard, mustache*, from kala *mouth*.

Digitized by Google

tsatsχok *piece, slice* (f.i. of meat).
χak *hair* (on head).
galak *more.*
hitanok *soon, in a short time.*
malek, in : nemuétan malek *eyelid.*
ok-mek *lion.*
oyuk *sack, pocket, bag,* cf. toyo *to put into.*
namek *dry wood.*
makik *yellow* 2) *gold.*
masslok *white;* 2) *cattle.*

This -k affix seems to indicate a spot or place and may be equivalent sometimes with "*on him, on it, on this.*" See the locative case below.

The existence of a fourth affix *-la, -lan, -lo* (o frequently alternates with a, both being probably surd ă), occurring as yet in substantive nouns only, may be inferred from the following words:

anip-'hei-la, enopχa-lo *moskito.*
apinki-llin *fly* of various colors, red, etc.
esva-lan *fish,* enko-ó-la *bird.*
haku-läno *valley* "where *water* is," cf. aχ *water.*
ka-la *mouth,* from ya-χa *to eat.*
kva-lo *stick,* in ne-χo-o-kvalo *gun, rifle* from kue, kve *wood.*
χa-lan *fever and ague,* from ka-a *sick.*
χa-lo *tumbler, drinking-glass,* from χane *to drink.*
massloχ-é-lan *snow,* from masslok *white.*
naχtchon-se-lon *fire-match,* from naχtchon *fire.*
tcho-ó-lan *excrements.*

-la is found also in the personal pronoun helat-la *he, himself,* but this is most likely the particle *ala,* which occurs in many other pronouns and is here apocopated, as the possessive élatan (*his, hers,* or *its*) demonstrates.

In the numeral series, this particle *ala* is used to form the decades or tens and may be rendered by "*times*":

sikbaχ *ten.*
sikbaχ ala kita *twenty,* (10 times 2).
sikbaχ ala mitish *thirty,* etc.

In spite of the small number of Tonkawa verbs, of which we are cognizant, some formative endings constantly recur, and we are therefore justified to consider them as derivational affixes forming verbs. One of them is *-aua, -ua:*

atsoχaua *to cool down,* from atsoχ *cool.*
hektaue *to sing.*
koχoχua *to breathe,* keshkua *to be fond of.*

Another, the sixth of our series, is *-ana, -ano, -ono* etc., which we discover in the following verbs:

shoyana *to swim.*
metan (instead of metana?) *to flash up* (said of lightning).
ne-shuano *to shoot.*

Digitized by Google

kẹ-vano *to be wet; wet, wetted.*

ke-eiχena *to be hungry; hungry, famished.*

χane *to drink* (same root as yaχa *to eat*).

shapon (instead of shapona ?) *to hide, to conceal.*

yalona *to kill.*

soskuono *to hear.*

This affix is evidently identical with the verb *eno, enu, tcheno,* which is rendered by *to be, to exist,* but whose primitive signification is that of *going* or *coming* (ena, aina).

Further verbal formatives can be traced in: *-aya, -oya:*

tchatchaya *to laugh,* yoχoya *to hunt,* toyo *to put into.*

in: *-na, -no:*

shokna *to put into,* tchoχno *to sleep.*

This ending probably originated through the syncope of verbs in *-ana, -ona, -ono* etc.

The most important affix and the ninth in our series is found in all the different categories of nouns (to the exclusion of verbs, probably). This is the affix *-n,* and its occurrence in participles of the active form of verbs seems to give the key to its real meaning. We have, f. i.:

tchoχnon *physician,* from tchoχno *to sleep, to lie in bed.*

atsoχauan *north wind,* from atsoχaua *to cool down.*

In the derivatives quoted hereafter this ending evidently has *different* functions to fulfill:

he-yatchon *eye glass,* from atche *to see.*

ayon *foot* (from aye *to move?*).

ye-koχon *boot,* from kaχa *to go.*

ye-tsoχan *house, tent,* from tsoχ *cloth, canvas.*

Kānoshan *Mexican,* from Kānosh *Mexico.*

táχshon *morning,* from tagash *sun.*

But the terminals *-an, -en, -in, -on, -un* appear also in a considerable number of nouns, whose roots, stems or their meaning are yet a mystery to us (*-kin, -χin* forms possessive pronouns), and of which we give here a short aperçu:

Adjectives:	χaton (also: χatana) *green.*	
	taχon *warm, hot.*	
Substantives:	etchnan *day.*	tan *tail.*
	nitχutan *paper.*	helepuen *forest, tree.*
	hepeian *beads.*	bopaχon *fox.*
	ya-tsoχgan *table-fork.*	tróniχon *grass,* etc.
	natun *hill, mountain.*	

Curiously enough, *-en* also stands at the end of the higher cardinal numbers, from fifteen upwards:

koskua *five,* koskua-en *fifteen,* sikbaχ-ala-kita kita-en *twenty-two.*

Tree or *wood* is kve, kue and the *shadow of a tree* is shaχe-i kauvan; hepeian is *beads,* and taχuaz-loman-hepaian is *neck-cloth, neck-kerchief.* From this we may conclude that *-n* in *kauvan* is the sign of an oblique

Digitized by Google

case, the *possessive*, and that hepaian simply means "on the neck," or "belonging to the neck," or "of the neck;" then hepai, hepei, or hepaia would be the term for *neck*.

Cases. By a similar analytical process we arrive at the discovery of a few other case-suffixes. Putting together the sentences in which the endings *-ak* and *-ok* are found, we get the following:

shaya yetsoχanak enubaha *I am not in the house.*
shaya yetsoχanak on be *I was not in the house.*
hetsho-olok yaχanoka? *What do you eat? What do you feed on?*
χananoke vauva *to die of poison.*

The two first sentences give us a *locative* case in *-ak*, the two latter an *instrumental* case in *-ok*.

The vowel *-u-* occurs at several places, where it seems to be a case-suffix, but is not yet demonstrable as such. If aχuelpa, for instance, which means *source, spring-water*, is composed of aχ *water* and he-lepuen *thicket, wood, tree*, (springs are often found near thickets), the inserted *-u-* can hardly be anything else but a case-suffix or a particle of relation; secondly: etatχono *to speak* is composed of eta *to come* and χon *a man, man* and therefore signifies in fact "*to come to a man.*" From this may be inferred, that *-t-* and *-o-* (*-u-*) are both particles of relation.

The ending *-sh*, which in verbs is used as a substitute for the pronouns shaya *I* and shaibaχ *we*, does not seem to be used as a case-suffix, but is found sometimes incorporated in the midst of words, as in naχtchon-se-lon *fire-match*, ya-tch-χenon *bread* (*ya-* prefix, yaχa *to eat*). As a final sound we find it in words like:

tagash *sun*, from taχon *warm, hot* (cf. Aztec tonatiuh *sun*, from tona *to be hot*).

nashish *terrapin.*	se-ketiesh *eight.*
auvash *buffalo* cf. au *deer.*	mish- in : mishbaχ *one.*
apinshos *common fly, house-fly.*	nosóss *young.*
mitish *three.*	há-ash *many.* (See : prefix *sh-*.)

Having discussed the more important features of T. grammar in my German publication, I shall not at present dwell any longer upon this subject, but pass over to the etymological dissection of some compound words and wind up with some ethnographical remarks of general interest.

In forming compounds of two substantives, the Tonkawa language places the depending *after* the governing substantive. *Man, male* means a-akon, in compounds akon; it occupies the first place in akon-kválo, the man of the staff or stick, viz.: *the chief;* it stands second in such terms, as designate objects for personal use, instruments, etc., f.i. okopák-χōn *hat* (lit. hat of man). Adjectives not used as predicates seem bound to stand behind the substantive or noun they qualify: aχ iχ *bad water*, akon vóχvan *little, young man, boy*.

From *atche to see* I derive the following terms: etchnan *day;* daylight, shining and seeing being ideas closely connected amongst themselves; tagash-aitchótak *the east*, lit.: "*sun-where-to see*," the direction in which

Digitized by Google

we first see the sun; he-yatchon *eye glass*. If na-ashod *moon* is a term formed after the "*aitchótak*" above, equivalent to "rising," "going-up" (na-aitchót?) and to the Klamath word ka-ukólĕsh *moon* (lit. "*the ascending one*"), it must also be derived from atche *to see*.

kue, tree, wood, stick, gave origin to the following T. words: akon-kvalo "the man of the stick," *the chieftain;* tsoχnetch-le-kvan *soap*, viz., "*stick* to wash cloth (tsoχ) with;" nitχutan-kve *lead-pencil*, viz., "paper-stick;" neχoo-kvalo *rifle, gun*, viz., "shooting-stick," probably misspelt for nesho-o-kvalo, ne-shuano meaning *to shoot*. Ekvuahen *horn* is probably derived from the same word, as horns frequently bear some resemblance to pieces of wood (instead of e-kvua-en?), and the numeral *six*, si-kualo, recalls the word kvalo, which is reduplicated in *nine*, se-kueskuelo.

teχon rock, stone reappears in ya-teχon *rock*, ni-s-teχon *ice* (water-stone!) and in helepuen-teχek *forest, thicket*, literally: wood of the hill. This refers to the circumstance that in the southwest forests are found on elevations only, while the plains remain bare of any woods.

atch earth, land turns up in etcho-χanásh *prairie-dog*, the well-known burrowing rodent of the west, Spermophilus ludovicianus, forming extensive underground colonies.

tsoχ cloth, canvas is the etymon of many terms mentioned above, and of: ye-tsoχe-i-tsan *button*, tchoχ-tchapol *blanket*, tsauχ-yetsuχan "*canvas-house*," *tent;* apparently also of: niese-tsoχ-kanov *dry, dried*, meaning perhaps a *cloth* (tsoχ) *dried* by the wind or the fire. Not knowing the original signification of tsoχ, we cannot decide if tchóχno *to sleep, to lie in bed* is derived from it or not.

a-atchoke rich is derived from ha-ash *much, many*, initial *h*- being deciduous in many of the Indian languages.

au deer, auvash *buffalo*, okau *fur-skin*, nauval *robe, animal-skin* are all derived from the same root *au*.

yentan, yandan wind forms yentan-auvei *the south*, lit. south-wind. Auvei, hauei is *strong* and the "*strong-wind*" is the breeze blowing with impetuosity from the coast of the Gulf of Mexico.

keta friend, partner, is identical with the numeral *kita two* and simply means "we two," or "two of us." From kita *two* are formed the numerals si-kuit *four* and se-ketiesh *eight*.

Conclusion.

The confutation of errors, whether they be of importance or not, is always attended with good results, and if we can profit in science and knowledge by such confutation, we should not lose the opportunity. It will not take long to prove with linguistic reasons, that the supposed affinity of the Tonkawas with the Caddoes does not exist.

Words and syllables in Caddo end almost *exclusively in vowels;* words of one syllable are scarce, almost every word has two or more syllables and in dissyllabic words the accent rests on the penultima. Diphthongs occur, but are often recognized with difficulty, owing to the queer method of

Digitized by Google

transcribing the language; groupings of consonants rarely occur, in T. frequently. *One simple consonant* generally heads the word and syllable; names for colors begin with *a-* or *os-*. The parts of the human frame mostly terminate in *-to, -co, -no, -son;* others begin with *oko-, okun-*, which would not be altogether disparate from the T. akon *man*, provided it has the same signification. It is true that the Caddo: nishe *moon*, aχkóto *cold, winter* bear some external analogy with the T. na-ashod *moon* and atsoχ *cool*, but there is often a wide difference between resemblance and real affinity. I have given elsewhere a collection of T. words resembling to terms of the surrounding idioms, which might be augmented indefinitely. Only one of the compared languages has yielded a few terms resting probably on real identity, and that is *Aztec*. We find T. (ya-) χa *to eat*, ka (-la) *mouth* and Aztec (tla-) ka, ka (-matl); T. hauei, auvei *great, large*, Azt. vei, huei; T. aχ *water* and Azt. atl. If these coincidences, which Tonkawa has in common with many Sonora languages, are increased by others, we may look out for proofs of old connections between the two ethnical bodies; connections through commerce, expeditions, emigrations or immigrations, not as yet through ethnological affinity. Up to this day a kinship of the Tonkawas with any other American nation or tribe has not been shown, and neither Aztecs, nor Shoshones or Caddoes can claim it on linguistic grounds. A faint resemblance could be traced in two Caddo terms only and phonology as well as grammar disagrees in most particulars from that of the Tonkawas.

NOTE.—Remember well, that the χ used here has *nothing to do* with the English *x*, but represents the harsh, guttural aspirate *kh* unknown to the English language.

On the Atmospheres of the Sun and Planets.

BY DAVID TROWBRIDGE, A. M.

Read before the American Philosophical Society, November 3, 1876.

There are two cases to be considered; in the first place we may suppose the body surrounded with an atmosphere, to be so hot as to influence, to a considerable extent, the density of the circumambient fluid; and in the second place we may regard the planet as cold like the earth, and as we suppose, Mercury, Venus, and Mars. I shall suppose the atmospheres composed of gases which are subject to the same laws as terrestrial gases.

1. Let us suppose the solar or planetary body to be a sphere of radius r. Also let z be the hight of any stratum of the atmosphere above the surface of the planet; ρ the density of that stratum; Z the force of gravity at the hight z; g the force of gravity at the surface of the planet; $\triangle$ the density of the atmosphere at the surface of the planet; p the pressure at the hight z; P at the surface; t_0 the temperature above 32° Fah. at the surface, and t at the hight z; λ the coëfficient of expansion; or the fraction expressing

Digitized by Google

the increase in volume for an increase in temperature of 1° Fah., so that if V_0 be any volume at the temperature of 32°, it will become $V_0 (1 + \lambda t_0) = V_1$ at the temperature t_0 above 32°; and at the temperature t above 32° the volume will be

$$V_0 (1 + \lambda t) = V_1 \left(\frac{1 + \lambda t}{1 + \lambda t_0}\right) = V \qquad (1).$$

Since the pressure is equal to the weight, we have

$$dp = \rho Z \left(\frac{1 + \lambda t}{1 + \lambda t_0}\right) dV_1 \qquad (2).$$

This equation applies for the hight z. We have

$$V_1 = \tfrac{4}{3} \pi [(r + z)^3 - r^3], \text{ and } dV_1 = 4 \pi (r + z)^2 dz \qquad (3).$$

$$Z = \frac{gr^2}{(r + z)^2} \quad (4), \qquad t = \frac{r^2 t_0}{(r + z)^2} \qquad (5).$$

Mariotte's Law gives

$$p = \frac{P}{\triangle}\rho, \quad dp = \frac{P}{\triangle} d\rho \qquad (6).$$

If we substitute these values in (2), and make the second member negative, since ρ decreases as z increases, we shall have

$$\frac{1}{\rho} d\rho = - 4 \pi gr^2 \frac{\triangle}{P(1+\lambda t_0)} \left[1 + \frac{r^2 \lambda t_0}{(r + z)^2}\right] dz \qquad (7).$$

The integral of this gives

$$\text{Log. } \rho + C = - 4 \pi gr^2 \frac{\triangle}{P(1+\lambda t_0)} \left[z - \frac{r^2 \lambda t_0}{r + z}\right]$$

When $z = 0$, $\rho = \triangle$, and $C + \log. \triangle = 4 \pi gr^2. \dfrac{r \triangle \lambda t_0}{P(1+\lambda t_0)}$, and

$$\text{Log. } \frac{\rho}{\triangle} = - 4 \pi gr^2. \frac{\triangle}{P(1+\lambda t_0)} \left[z + \lambda r t_0 - \frac{r^2 \lambda t_0}{v+r}\right], \text{ or}$$

$$\text{Log. } \frac{\rho}{\triangle} = - 4 \pi gr^2. \frac{\triangle z}{P(1+\lambda t_0)} \left[1 + \frac{r \lambda t_0}{r+z}\right] \qquad (8).$$

Now make

$$\frac{4 \pi gr^2 \triangle}{P} = \frac{1}{R} \qquad (9);$$

then we have

$$R \log. \frac{P}{\triangle} = - \frac{z}{1 + \lambda t_0} \left[1 + \frac{r \lambda t_0}{r + z}\right] \qquad (10).$$

Let us take the surface of the earth as the unit of surface, the radius of the earth as a linear unit, and the force of gravity at the earth's surface as the unit of gravity.

2. Let D' be the density of mercury at the temperature of 32°, and D'' its density at t_0 above 32°; then, if λ' be the coëfficient of expansion for a volume of mercury,

$$D' = (1 + \lambda' t_0) D'' \qquad (11).$$

Let h′ be the hight of a column of mercury on the unit of surface, and at the temperature of 32°, that will just balance a column of atmosphere

Digitized by Google

on the same surface, h'' the hight of a column of mercury on the unit of surface on a planet, at the temperature t_0 above 32° ; then the mass of the first column will be $4\pi h'D'$ very nearly since h' is about 30 inches, and the weight will also be $4\pi h'D'$, and this will be equal to P_0 the pressure on the unit of surface on the earth. Hence

$$P_0 = 4\pi h'D' \qquad (12).$$

The mass of the second column will be

$$4\pi h''D'' = \frac{4\pi h''D'}{1 + \lambda' t_0} \qquad (13);$$

and the weight will be $\frac{4\pi h''gD'}{1+\lambda' t_0}$, which is equal to the pressure P on the unit of surface. Hence

$$P = \frac{4\pi h''gD'}{1 + \lambda' t_0} \qquad (14).$$

So long as the temperature is constant the density is proportional to the pressure ; or $P_0 : P :: \triangle_0 : \frac{P\triangle_0}{P_0}$; and under different circumstances of temperature the density is inversely as the volume for the same mass, so that for the temperature t_0 above 32°, the density just found will become $\frac{P\triangle_0}{(1 + \lambda t_0)P_0}$, and this must represent the actual density $\triangle$ at the surface of the planet. Hence

$$\triangle = \frac{\triangle_0}{(1 + \lambda t_0)} \cdot \frac{P}{P_0} = \frac{4\pi h''gD'}{4\pi h'D'(1+\lambda' t_0)} \cdot \frac{\triangle_0}{(1+\lambda t_0)} = \frac{\triangle_0 gh''}{h'(1+\lambda' t_0)\,(1+\lambda t_0)} \qquad (15).$$

3. Let m be the mass of any one of the planets, that of the Earth being 1, A the mass of the Earth's atmosphere, and KAm that of the planet's, then

$$A = 4\pi h'D' \qquad (16);$$

and $$KAm = \frac{4\pi h''D'r^2}{1 + \lambda' t_0} \qquad (17);$$

and hence

$$\frac{KAm}{r^2} = KAg = 4\pi Kgh'D' = \frac{4\pi h''D'}{1 + \lambda' t_0}, \text{ or}$$

$$h'' = Kh'g\,(1 + \lambda' t_0) \qquad (18).$$

This value in (15) gives

$$\frac{\triangle}{\triangle_0} = \frac{Kg^2}{1 + \lambda t_0} = \frac{P}{P_0\,(1 + \lambda t_0)} \qquad (19).$$

Equation (10) is independent of the extent of surface on which the atmosphere presses, since it gives only the law of the variation of density of the atmosphere in ascending through it. R is therefore a linear measure, and on the Earth it has been found from observations to be 26,126.5 English feet, or 4.948 English miles. To compare this with a similar quantity for any one of the planets, we must make $r = 1$ in Eq. (9), and we shall make

$$4\pi R_0 = \frac{P_0}{\triangle_0} \qquad (20), \qquad 4\pi gR' = \frac{P}{\triangle} \qquad (21),$$

Digitized by Google

in which $R_0 = 4.948$ miles. These equations give

$$\frac{gR'}{R_0} = \frac{P}{P_0} \cdot \frac{\triangle_0}{\triangle} = 1 + \lambda t_0 \text{..........................} (22).$$

In Eq. (10) we must therefore substitute for R the value $R' = \frac{(1+\lambda t_0)R_0}{g}$, which gives

$$R_0 (1 + \lambda t_0)^2 \log. \frac{\rho}{\triangle} = - gz \left[1 + \frac{r\lambda t_0}{r+z}\right] \text{..............} (23).$$

Equation (23) is independent of K, which depends on the mass of the planets' atmosphere, as it should be since we have neglected the attractive influence of the atmosphere. This seems allowable since the mass of the Earth's atmosphere is but a small fraction of the mass of the Earth.

4. Now let $t_0 = 0$ in (23) and the resulting equation will apply to an atmosphere of 32° Fah.

$$R_0 \log. \frac{\rho}{\triangle} = - gz \text{..................................} (24).$$

To make some application of these formulas we shall take $g = 1$ and $\triangle = 2\rho$, and since N log. 2 = 0.6931472 we find $z_1 = 3.4297$ miles; and for $\triangle = 4\rho$ we have $z_2 = 6.8594$ miles, and so on, $\triangle = 2^n\rho$ giving $z_n = nz_1$.

Now let us suppose $g = 1$ and $\lambda t_0 = 1$, then, $\triangle = 2\rho$, $4z_1 = z + \frac{rz}{r+z} = \frac{z^2 + 2rz}{r + z}$, and $z_1^1 = -(r - 2z_1) \pm \sqrt{r^2 + 4z_1^2}$.

We must reject the negative value, and for the other we have

$$z'_1 = 2z_1 + \frac{2z_1^2}{r} \text{ very nearly, } = 6.8649 \text{ miles.}$$

In a similar manner we find $z'_2 = 13.7425$, or $z'_2 = 2z'_1 + 0.0127$ miles. We should also find $z'_3 = 3z'_1$, very nearly, for $\triangle = 3\rho$; and so on.

We thus see that if the Earth were 490° Fah. warmer than it now is $\left(\text{since it is found that } \lambda = \frac{1}{490}\right)$; or in other words, if its own heat was such as to heat the air in contact with it to 490° more than 32° (supposing it to be 32° now), and to vary according to the law which we have supposed, the density of the atmosphere would be one-half what it is at the surface at the hight of about 7 miles, instead of 3½ as at present; and one-fourth the density would be reached at about 14 miles, and so on. The hight of the atmosphere under such conditions would be more than double what it now is. If we suppose the density at the surface of the Earth to be about a million times as great as at the surface of the atmosphere, or $\triangle = 2^{20}\rho$, we shall find $z = 139$, nearly, under the conditions of high temperature; while in the other case it will be but 69 miles.

For the temperature which we have supposed the Earth to have, it would scarcely give out any light. To suppose the body self-luminous, it will be necessary to make t_0 about twice what we have supposed. We shall now make an application of our formulæ to the planet Jupiter, and since that

Digitized by Google

planet seems to be brighter, or to give out more light than what it reflects from the Sun, we shall suppose λt_0 equal to 2. The force of gravity on Jupiter is about 2.42 times terrestrial gravity ; and if we make some allowance for an extensive Jovian atmosphere we may perhaps call $g = 2.5$.

If these values be put in Eq. (23), and we make $\triangle = 2\rho$, we shall have $3.6z_1 = \frac{z^2 + 3rz}{r + z}$, and $z = 1.2z_1$ nearly, $= 4.1156$ miles.

If we make $t_0 = 0$ we shall find $z = 1.3718$ miles, or about one-third of the other value. In a similar manner we shall find for the relation $\triangle = 4\rho$, $z = 8.2313$ miles, and so on.

If in Equation (19) we make $K = 1$, and $\lambda t_0 = 2$, we shall have $\triangle = 2\triangle_0$ ..(25) very nearly. Thus at the hight of about 4 miles the density of the Jovian atmosphere will, upon these suppositions, be the same as the density of the Earth's atmosphere at the surface of the Earth. If we suppose, as Mr. R. A. Proctor has done, that the density of Jupiter's atmosphere where the cloud-layers exist, is one-fourth of the density of the Earth's atmosphere at the Earth's surface, we shall have z for that case about 12 miles instead of 100 as he supposes. According to this investigation, then, Jupiter's atmosphere at his surface is either very dense, or its extent is not so great as Mr. Proctor imagines; or his temperature at the surface is greater than 1000° Fah.

We may perhaps reasonably assume $\triangle = 2^{50}\rho$ on Jupiter, and this value will give the hight of his atmosphere about 206 miles; and if we suppose $\triangle = 2^{20}\rho$ we shall find z equal to about 82 miles.

If we call $K = 1$, $t_0 = 980°$, $\lambda' = \frac{1}{490}$, $g = 2\frac{1}{2}$, we shall find, by Eq. (18), the hight of the barometer on Jupiter $82\frac{1}{2}$ inches. By Equation (19), we find upon the same suppositions that the pressure to the square inch, of Jupiter's atmosphere on his surface, is equal to $93\frac{3}{4}$ pounds.

If we take for Saturn $g = 1.1$, $\lambda t_0 = 2$, $\triangle = 2\rho$, we shall find $z = 9.3537$ miles; and for $\triangle = 2^{20}\rho$, $z = 187$ miles; and for $\triangle = 2^{50}\rho$, $z = 468$ miles. If we take $K = 1$, Eq. (19) gives $\triangle = \frac{2}{3}\triangle_0$, and the pressure to the square inch equals 18 pounds. The hight of the barometer by Eq. (18) equals 36 inches.

To make some application to the Sun, I shall assume $\lambda t_0 = 49$, which will give a temperature of the Sun's surface sufficiently high to correspond with our knowledge of the subject. We also have g equal to 27.2 ; and if $\triangle = 2\rho$ we find $z = 6.304$ miles. If we suppose $\triangle = 2^{1000}\rho$, we shall have $z = 6304$ miles as the corresponding hight of the solar atmosphere. We also find $\triangle = 15\triangle_0$ very nearly, if $K = 1$; and the pressure to the square inch is about 11000 pounds. The hight of the barometer would be 234.6 feet.

In these applications we have assumed $K = 1$ which supposes the mass of the atmosphere proportional to the mass of the planet which it surrounds. In the absence of all real knowledge on the subject we may as well make that assumption as any. The probability is that this supposition is an ap-

Digitized by Google

proximation to the truth. Equation (23) is independent of any supposition in relation to this matter.

5. In the following table I have arranged the various elements of the planetary atmospheres, which have been the subject of the foregoing investigation, on the supposition that $K = 1$, and $t_0 = 0$.

Planet.	Value of z for $\triangle = 2\rho$, in Miles.	Density at Surface.	Pressure at Surface on 1 sq. in. in lbs.	Hight of Barometer in inches.	Hight of the Atmosphere in Miles.
Mercury.....	7.40	0.214	3.21	13.9	719
Venus.......	3.92	0.765	11.47	26.2	392
Earth........	3.43	1.000	15.00	30.0	343
Mars........	11 31	0.092	1.38	9.1	1095
Jupiter......	1.42	5.856	87.84	72.6	146
Saturn	3.12	1.210	18.11	33.0	313
Uranus......	5.20	0.530	7.95	21.8	515
Neptune.....	4.36	0.615	9.22	23.5	436

The last column of this table, or that which gives the hight of the atmosphere, is based upon the supposition that the exterior limits of the planetary atmosphere have the same density for all, and that the Earth's atmosphere has a hight of 343 miles. It is not a little curious at first sight that Jupiter's atmosphere should be the least extensive in hight, while Mars's is the most extensive; but this is due to the great attractive influence of the one, and the smallness of the same element in the other. Though this table is based on an uncertain hypothesis, yet it seems to me that it is considerably instructive. Besides, the preceding theory will serve to test some of the hypotheses which are offered to account for the surface appearances of Jupiter.

The peculiar figure which Sir William Herschel found Saturn to present, which Bessel and others could not discover, and which Airy could not explain upon the theory of gravitation, is accounted for without difficulty by the currents in his atmosphere, as will be seen by consulting Wm. Ferrel's *Treatise on the Motion of Fluids relative to the Earth's Surface*, Art. 18, Fig. 1, Vol. I, *Math. Monthly;* and if Jupiter's atmosphere were sufficiently extensive he ought to present a similar figure.

Waterburgh, N. Y., October 19, 1876.

NOTE.

Since the above was written I have seen a report of Prof. S. P. Langley's experiments to determine the temperature of the solar surface. Physicists have heretofore differed considerably in their estimates of the Sun's temperature, Secchi putting it as high as 18 millions of degrees Fah., St. Claire Deville and others, between 3,000° and 20,000°. Prof. Langley's result favors the higher number. For convenience of calculation let us assume the solar temperature equal to 9,800,032° Fah., so that $\lambda t_0 = 20{,}000$.

Now let $K = 1$, then we find, by Equation (19), $\triangle = 0.0369\triangle_0$; or the

Digitized by Google

density of the solar atmosphere at the surface of the Sun, is but little more than one-half the density of hydrogen at the surface of the Earth, and at a temperature of 60° Fah. The pressure on a square inch of surface, is about 11,000 pounds Avoir. In the case of the Earth the density of the atmosphere at the surface of the Earth, is to the density at the surface of the atmosphere, at least as great 2^{100}: 1. If we assume the same ratio to hold for the Sun's atmosphere, Eq. (23) will give us for the hight of the solar atmosphere, 426,000 miles, or about the radius of the Sun. If we make $t_0 = 0$, we shall find the hight of the atmosphere, with the same ratio of densities, about 12½ miles; the density at the Sun's surface about 740 times that of the Earth's atmosphere at the surface of the Earth, or nearly equal to the mean density of the Sun. It will be noticed that in the case of high temperature, if we assume $K = 10$ (a very improbable value, it being too large), we still have $\triangle = 0.369_0\triangle_0$, which gives a rare atmosphere. The following table will give the density at different hights above the Sun's surface:

Relative Density.	Hight in Miles.	Absolute Density, or $\triangle_0 = 1$.
$\triangle = 1$	0	0.03699
$\frac{1}{2}$	2536	0.01849
$\frac{1}{4}$	5104	0.00924
$\frac{1}{8}$	7702	0.00462
$\frac{1}{16}$	10330	0.00231
$\frac{1}{32}$	13000	0.00116
$\frac{1}{64}$	15683	0.00058
$\frac{1}{128}$	18403	0.00029
$\frac{1}{256}$	21362	0.00014

These numbers will help us to explain the rapid movements which Prof. C. A. Young and others have noticed in the solar atmosphere. If gases are pent up beneath the solar surface, but finally escape with great force, the rare atmosphere of the sun would not retard the motion like a dense one. The less rapid motion may be due to difference of specific gravity. The density of the hydrogen clouds can be calcnlated from the formulæ which have been given in the text. D. T.

November 24, 1876.

[*Minutes continued from page* 292.]

The minutes of the last meeting of the Board of Officers and Members in Council were read, and the recommendations of the Board were acted upon as follows:

A committee of five, to be appointed by the Chairman, after consultation, was, on motion of Mr. Price, ordered, who should accept Mr. Wooten's invitation, and examine his anthracite slack fires at Reading, or elsewhere along the line of the Reading Railroad.

Digitized by Google

The curators, on motion of Dr. Cresson, were requested to inquire of the Superintendent of the United States Mint whether it were practicable to arrange for the safe keeping and public exhibition of the cabinet of coins of the Society, in the Mint.

The librarian, was, on motion, authorized to proceed with the printing of the catalogue of the library, beginning with division VI; and directed to report to the Finance committee the plan and cost of the work. The Librarian explained that division VI, VII, and VIII, would make a volume nearly as large as that of division I to V, already published; and that division VI (Sociology, Commerce, Manufactures, War and Law) is ready to go to press, every title having been verified by reference to book or pamphlet. The other divisions (VII, Language, Belle Lettres, Fine Arts, Ethics, Metaphysics, Philanthropy and Religion; and VIII, Biography and Newspapers) will be ready for the press by the time division VI is printed. The press work must attend on a careful proof reading, and be therefore slow. The whole cannot be finished in less than eighteen months.

Pending nominations 809, 810, 811, 812 were read.

The name of Dr. James Gibbons Hunt was ordered to be taken from the roll of members, at his request.

Judge I. I. Hare's resignation on account of his inability to attend any meeting of the Society, was accepted.

Mr. Fraley reported the receipt of the quarterly interest of the Michaux Legacy, due Oct. 1st ult., $145.45, and its payment to the Treasurer.

Mr. Price offered the following resolution, which was discussed and passed:

Resolved, That this Society consents that, after providing for the Michaux grove of oaks, and for cultivation of other oaks in the park nursery, as provided by the resolutions of the Fairmount Park commissioners of March 12 (17?)th, 1870, and agreed to by the society on the 18th of March, 1870, the residue of the income of the Michaux legacy paid over to the Park commission may be applied to the pur-

Digitized by Google

purchase of other trees; and such other trees as well as oaks may be distributed not only to other parks, but to city squares, and in exchange with other public nurseries, and towards planting the grounds of institutions of learning and charity, to any extent that will not impair the primary purpose of said agreement of March, 1870.

And the meeting was adjourned.

Stated Meeting, Dec. 1st, 1876.

Present, 13 members.

Mr. Eli K. Price, in the Chair.

Letters of acknowledgment were received from the Societies at Göttingen July 15, (Proc. Vol. XIV) and Emden (94), and the Smithsonian Institution, July 22d (97).

A letter of envoy was received from the Society at Emden.

Donations for the Library were reported from the Academies and Societies at St. Petersburg, Berlin, Moscow, Emden, St. Gallen, Cherbourg, and Rotterdam; the Revue Politique, and London Nature; the Royal Astronomical, Geographical and Zoölogical Societies; the Museums at Cambridge, and Albany; New York State Library; Poughkeepsie Society of Natural Science; Professor E. D. Cope; and the Brazilian Centennial Commissioners.

On the report of the curator present of an interview with the superintendent of the mint, it was resolved that the report be adopted and the curators be requested to take such further measures as may be necessary for the placing of the Society's collection of coins under the care of the officers of the United States Mint.

Professor Hart read a paper entitled, "The Fairy Folk, or Fairy Lore of Spencer and Shakespeare," giving the romance or latin origin of the words fairy, &c., in contrast with the teutonic origin of the words elf, &c., assigning different characters to this species of imaginary creatures, supporting the distinction by numerous quotations, and the recital

Digitized by Google

of numerous typical legends. He defended his theory that Shakespeare's fairy lore was taken wholly from the life of the english people and was essentially and wholly teutonic, while Spencer's fairy characters represented the southern or romantic ideas of the world of enchantment.

The Annual Report of the Treasurer was read.

Pending nominations, Nos. 809 to 812, and new nominations, Nos. 813 to 822, were read.

On motion of Mr. Briggs, it was resolved that the words, "and report to the Society, on the originality of the process of Mr. Wooten, and whether it is deserving of the premium of $500 offered by the Society (Nov. 16th, 1866,) for the utilization of Anthracite Coal Slack," be added to the resolution passed at the last meeting to give it effect.

And the meeting was adjourned.

Stated Meeting, December 15*th*, 1876.

Present, 15 members.

Secretary, Professor Kendall, in the Chair.

Mr. Frank Thompson, a newly elected member, was introduced to the presiding officer, and took his seat.

A photograph of Professor Alfred M. Mayer was received for the album, in a letter dated Stevens Institute, Hoboken, Dec. 11th, 1876.

The resignation of Mr. C. E. Smith was received by letter dated Dec. 9th, 1876, and on motion accepted.

The resignation of Dr. F. G. Smith was received through the Treasurer, and on motion accepted.

Letters acknowledging the reception of publications of the Society were received from Prof. Owen, dated British Museum, Nov. 24th (97); the London Statistical Society, Somerset House Terrace, Kings College Entrance, Strand, W. C., Nov. 28th (97); the Victoria Institute, Adelphi Terrace, Strand, W. C., Nov. 23 (97); and the Society of Antiquaries, Burlington House, Piccadilly, London, W. Nov. 22d, (97).

Digitized by Google

A letter of envoy was received from the Meteorological Office, London, Nov. 1876.

Donations for the Library were received from the Verein für Kunst at Ulm; Geographical Society and Revue Politique, Paris; Meteorological Committee and London Nature; Canadian Naturalist; Vermont Historical Society; Boston Natural History Society; E. L. De Forrest and Silliman's Journal; Editors of the Sanatarian, and American Chemist, New York; Penn Monthly; American Journal of Pharmacy and Medical News; and Bureau of Education at Washington.

A letter being read from the Deputy Secretary of the Commonwealth, dated Bellefonte, Pa. Dec. 2d, 1876, asking permission to copy the MSS. journal of Colonel Bard in 1756, at Fort Augusta, in the library of the Society, for publication in the new series of Archives of Pennsylvania, which was granted.

Mr. Walter made a communication to the Society upon the erroneous nature of certain statements respecting the foundations of the great tower of the Public Buildings at the corner of Broad and Market Streets.

Mr. Walter called the attention of the Society to some remarks which were made at the Stated Meeting held January 21, 1876, in which the foundations of the Tower of the New Public Buildings were referred to in a manner calculated to lead to erroneous impressions, and to shake the public confidence in that great work.

The remarks alluded to are found on page 181, Vol. xvi, No. 97, of the Proceedings, and are as follows: "Mr. Blodget recounted the experience of those who laid the foundation of the Masonic Temple, Broad and Filbert, where two gravels were found separated by three feet of quicksand, which required two powerful steam pumps 6″ and 8″ working night and day. The top of the quicksand layer was accidentally uncovered at the corner of the lot 40 feet deep, and this obliged the plan for laying the foundation to be entirely changed, at an expense of say $30,000.

"The great Tower of the Public Buildings, opposite to the Masonic Temple, has its foundation laid in the upper gravel, and there is a possibility of future disaster from the subjacent quicksand."

Mr. Walter stated that the foundations of the tower of the Masonic Temple were laid in what was formerly a ravine, as the dip of the strata underlying the Penn Square site clearly indicates, so that the vertical section of the excavations for the towers of the Temple will be found to be

Digitized by Google

very different from that of the excavations for the tower of the Public Buildings, and can in no wise be accepted as an indication of a want of stability in the underlying strata of the latter structure. He remarked that he obtained from Mr. Windrim, the Architect of the Temple, a memorandum of the thickness and character of the several strata through which the excavation passed, in reaching the foundation of the Tower, and which does not agree, in any particular, with the statement recorded in the proceedings of the Society.

According to Mr. Windrim, the first, or upper stratum was 10 feet in thickness, consisting of a sandy loam, resting on a clay bed of 5 feet deep, underlying which occurred a stratum of sandy loam 12 feet thick ; at about 2 feet from the bottom of this, or 25 feet below the street curb, the loam was permeated with water, supposed to have percolated through the ground when the adjacent squares were open. The next 10 feet consisted of stratified gravel, at the bottom of which it became hard, and at the depth of 1 foot more, being 38 feet below the street curb, the foundations were laid in a substratum of hard, compact gravel.

Mr. Walter remarked that he considers it proper thus to refer to the foundations of the tower of the Masonic Temple, as the statement in the Society's proceedings deduces from what is there erroneously said respecting the Masonic structure, that there existed a possibility of future disaster to the great tower of the Public Buildings. Such an inference is not only unfair and unjust, but it is damaging to public confidence in a great public work, and highly detrimental to the professional reputation of its architect.

The error of such an inference cannot fail to be apparent in view of the actual geological formation of the strata in which it is founded, and the manner of its founding. It is altogether a mistake to suppose that this great tower has its foundations "laid in the upper gravel." The facts are that in digging the foundation in question the first stratum passed through was the ordinary sandy loam, under which occurs a clay bed varying from 4 to 6 feet in thickness; then follows a stratum of gravel, and below that one of sandy loam stratified with gravel and permeated with water from the surface drainage, producing what is sometimes called quicksand ; underlying this the hard gravel commences, and continues increasing in density as it increases in depth, until it assumes the character of "water gravel," from which rises the natural flow which supplies our wells. This stratum is some 10 feet in thickness, and in this the Tower of the Public Buildings is founded. After the excavation had been made, and prepared to receive the structure, a well was dug in the centre for the purpose of ascertaining the nature of the underlying soil, when it was found to consist of hard gravel, solid and compact throughout. This heavy stratum of gravel through which the natural spring water percolates, being considered by architects as the best possible foundation for a heavy structure, rock alone excepted.

Mr. Walter further stated that the foundation of this great Tower is 96

Digitized by Google

feet square, and 8 feet 6 inches deep, containing about 78,000 cubic feet, consisting of one entire mass of solid concrete, covering the whole space, and pressing equally upon its gravel bed, with which it in some measure necessarily amalgamates; and that in view of these facts, and of all the skill, care, and foresight that have been exercised in founding this, the greatest tower of the world, we need be under no apprehension of "the possibility of future disaster" to the structure.

Mr. E. K. Price, as Chairman of the Committee on the application of one-half of the income from the Michaux Legacy to botanical purposes, made a report on the Michaux and Cresson Trusts.

On motion it was: Resolved, that five hundred extra copies of the Report be printed for circulation and future use in the execution of the Trusts of the Cresson and Michaux Trusts.

Mr. Lesley read a paragraph from a recent private letter of M. Leo Lesquereux respecting new discoveries in the Carboniferous Flora of North America.

Mr. Lesley communicated a collection of Oil-well records made by Mr. J. F. Carll, Assistant on the Geological Survey of Pennsylvania, in charge of the survey in the Oil Regions of the State, with remarks on their value to men abroad and at home.

Professor Chase called attention to the Swedish statistics of color blindness.

Mr. Thompson described the investigations carried on at the shops at Altoona by the Pennsylvania Railroad Company, into the values of various signal lights and their possible combinations; and stated that in the experiences of that company not a single instance had been found among the employés of such color blindness as practically incapacitates an employé from using the series of four colors, white, green, red, and blue, to which signal lights are confined.

The report of the Finance Committee was read.

The annual appropriations for the ensuing year recommended in the report were, on motion, ordered.

Pending nominations, Nos. 809 to 822, and new nominations, 823 to 829, were read.

And the meeting was adjourned.

Digitized by Google

The Michaux Trees.

(Report of Committee read before the American Philosophical Society, December 15, 1876.)

To the American Philosophical Society and to the Fairmount Park Commissioners:

The Chairman of the Committee on the Michaux Fund of the said Society, and of the Committee on Trees and Nurseries of the latter, respectfully reports:

That he regards this year, 1876, as an era, from which will date a large advancement in the matters under the care of said Committees. Before it began very valuable importations of the rarest oaks had been made and planted in the Park Nursery, from which the first transplantations have lately been made into the Park grounds, and a few of them have been ordered into the *Campus* of the University of Pennsylvania this fall. Some planting out of the various trees in the Nursery had been made in the Park along the few avenues opened, and 1639 trees have been planted over the space occupied for the Centennial International Exhibition. The formation of the grounds within that space by the Board of Finance of the Exhibition and the planting therein are an invaluable acquisition to the Fairmount Park, as open waste fields have thereby been converted into beautiful gardens, with avenues, walks and fountains. It is true, that the garden of the Horticultural Hall was, to a large extent, planted with trees and flowers by Foreign and American exhibitors. James Veitch & Sons, of King's Road, Chelsea, S. W., near London, presented to the Park Commissioners their valuable collection of trees and plants, consisting chiefly of Rhododendrons.

The American exhibitors who had collected and planted in the garden of Horticultural Hall a rare variety of trees and ligneous plants were Thomas Meehan, of Germantown; Hoopes, Brother & Thomas, of West Chester, Pa.; S. B. Parsons & Sons, and R. B. Parson & Co., of Flushing, N. Y.; Miller & Hayes, of Mount Airy, Philadelphia; Mahlon Moon, of Morrisville, Pa.; and Robert Buist, of Philadelphia. They were actuated by a liberal desire that their collections should remain in the Park, and offered them at prices which they esteemed little over half the cost to them. It was an object to the Commissioners to secure these permanently for our Park, to be transplanted as thinning out shall be required for their healthy growth, and they have been secured by purchase.

The resources for this purchase should be here stated. They were as follows:

The city's appropriation, by the Park Commission applied for Nurseries in 1876..........	$1,500 00
Accumulated Interest on Elliott Cresson's Legacy..........	8,000 00
" " André F. Michaux's Legacy..........	414 60
Contributions by the following persons of $100 each, to wit: William L. Schaffer, George C. Thomas, Charles H. Rogers,	

Digitized by Google

Samuel Jeanes, Joseph Jeanes, Joshua T. Jeanes, Isaac F. Baker, Eli K. Price	$800 00
Moses Brown and J. C. Strawbridge, each $50	100 00
Together	$5,814 60

As the legacies of Elliott Cresson and André F. Michaux are enduring funds for planting in the Fairmount Park and elsewhere, it is proper here to show what are the trusts of those wills, and what are the obligations to the public incurred by the Park Commission in executing the agency committed to them.

ELLIOTT CRESSON'S LEGACY.

Elliott Cresson, by his last will and testament, made in 1857, provided as follows:

"I give and bequeath to the Mayor and community of Philadelphia the sum of $5,000, in trust, as a perpetual fund, the income of which I desire shall be annually, forever, expended in planting and renewing shade trees, especially in situations now exposing my fellow citizens to the heat of the sun."

An ordinance to provide for the investment of the principal and the application of the income of the Legacy of Elliott Cresson, Esq., to the City of Philadelphia, was passed June 10, 1859.

"A SUPPLEMENT

"*To 'An Ordinance to provide for the investment of the principal and the application of the income of the Legacy of Elliott Cresson, Esq., to the City of Philadelphia,' approved June* 20, 1859.

"Section 1. The Select and Common Councils of the City of Philadelphia do ordain, That the income of the fund bequeathed to the City of Philadelphia by Elliott Cresson, Esq., shall be expended in accordance with his will, by the Commissioners of the Park, constituted pursuant to the Act of Assembly; approved March 20, 1867."

The will of André Francois Michaux, of Vawreal, near Pointoise, France, dated the 4th September, 1855.

It revokes former wills. It declares as follows:

"Wishing to recognize the services and good reception and the cordial hospitality which my father and myself, together and separately, have received during our long and often perilous travels, in all the extent of the United States; as a mark of my lively gratitude, and also to contribute in that country to the extension and progress of agriculture, and more especially in sylviculture in the United States; I give and bequeath to the American Philosophical Society, at Philadelphia, of which I have the honor to be a member, the sum of twelve thousand dollars (at 5.50 the dollar, 64.800 francs). I give and bequeath to the Society of Agriculture and Art, &c., in the State of Massachusetts, Boston, in which I have the honor to be a member, the sum of eight thousand dollars (at 5.10 the dollar is, 43.200) these two sums together making one hundred and eight thousand francs, or again twenty thousand dollars. I give and bequeath the sole ownership

Digitized by Google

to these two above said Societies, and the usufruct to my aforesaid wife for her life."

The American Philosophical Society, believing that they could best execute their trust as to half the income of the Michaux Legacy in the Fairmount Park, made the following arrangement for that purpose:

"*Office of the Commissioners of Fairmount Park, No.* 224 *South Fifth Street, Philadelphia, March* 12*th*, 1870.

"At a meeting of the Commissioners of the Park, held this day, the following preamble and resolutions were adopted:

"*Whereas*, The American Philosophical Society has made a communication to this commission, proposing that the name of André Francois Michaux, who traveled long in this country, and described our oaks and forest trees in a work of great merit and splendor, should have his name, and that of his father (who had, by like travel and study rendered service to science,) honored in the Fairmount Park, in a manner, to be a memorial to their devotion to science, and to promote the objects which had occupied their lives, and has proposed, after the death of the widow of André Francois Michaux, to devote the interest or income of six thousand dollars bequeathed by him to said Society, to be expended in execution of the trust of his will in the said Park, for the purpose following; therefore,

"*Resolved*, That there shall be a grove of oaks in the Fairmount Park, forever, to bear the name of 'The Michaux Grove,' in which, if practicable, shall grow two oaks of every kind that will endure the climate.

"*Resolved*, That any surplus of revenue received by the commission from the Michaux Fund, after satisfying the requirements of the preceding resolution, shall be devoted to the cultivation of oaks of every variety capable of cultivation in our climate, in the Park nursery; which oaks, to the extent of two of each kind cultivated, be hereafter distributed to other Public Parks in the United States, under proper regulations to be hereafter prescribed."

Resolved, That this Society do agree to the terms contained in the preamble and resolutions of the Fairmount Park Commissioners, adopted on the 12th day of March, 1870, in the expectation and confidence that the planting of the Michaux Grove of Oaks may soon be commenced, so that the Grove shall early become one of the attractions of the Park." Proceedings, Nov. 83, p. 312.

There appearing to be scope for a more extended benefit to be accomplished within the intention of Mr. Michaux, the powers of the Park Commission were extended by the American Philosophical Society.

At a meeting of the American Philosophical Society, November 17th, 1876, it was

Resolved, That this Society consents that, after providing for the Michaux Grove of Oaks, and for cultivation of other oaks in the Park Nursery, as provided by the resolutions of the Fairmount Park Commissioners, of March 12th, 1870, and agreed to by this Society on the 18th of March, 1870, the residue of the income of the Michaux Legacy paid

Digitized by Google

over to said Park Commission may be applied to the purchase of other trees; and such other trees as well as oaks may be distributed not only to other Public Parks but to City Squares, and in exchanges with other Public Nurseries, and in planting the grounds of Institutions of Learning and Charity, to any extent that will not impair the primary purposes of said agreement of March, 1870.

In respect to the intention of Elliot Cresson's will, to wit, "in planting and renewing shade trees, especially in situations now exposing my fellow citizens to the heat of the sun," the testator is to be taken to mean the greatest good to his fellow citizens by the shade of trees, and that would be where they most frequent, consistently with the requirements of business. It would not be to place trees in the thronged streets where such plantings would be obstructive and mask all business signs; but would properly be in all our public squares; in streets where people are yet so few as to permit the growth of trees without unduly obstructing passengers; certainly in the East Park, as Mr. Cresson knew it; and with a necessary expansion as business shall extend, to drive away such planting, and to follow the growth of the city, as the citizens move outward, and the Parks as they shall become more central and thronged. Charities are to be executed as near the intention as reasonably practicable; City and Girard heirs, 9 Wright's Reps. 9; and follow the growth and needs of their objects.

The Park Commission have from the Michaux legacy made importations that have given them the best collection of young and rare oaks in the country, containing about 1200 growing trees.

From the income of the Cresson legacy they have supplied two hundred dollars for trees in Independence Square, and have voted six hundred trees for the other Public Squares, from the Park Nursery; and two hundred and fifty trees for planting round the grounds of the University of Pennsylvania, and the University Hospital. The contiguous streets opened through the Almshouse ground, and elsewhere as new streets shall be opened, or built upon, might be supplied with trees from the Park Nursery.

There are now growing in the Park Nursery nearly eighty thousand trees and shrubs, of which about thirty thousand are of a size to plant out. Of the latter, there are, of *Arbor Vitæ*: American, 5,000; Siberia, 711; Tom Thumb, do., 1,047; Globe, do., 150; Hovey, do., 350; of White Pine, 350; Australian Pine, 200; Scotch Pine, 200; Balsam Fir, 600; Junipers, 370; Norway Spruce, 2,400; White do., 850; Hemlock, 500; Golden Willow, 32; Sweet Gum, 350; Tulip Poplar, 700; Cypress, 360; Forsythea, 400; Althea Var., 200; Mahonia, 30; Althea, 5,200; Norway Maple, 500; Privet, 150; European Larch, 30; European Birch, 240; English Elm, 400; Sugar Maple, 350; American Ash, 800; American Elm, 1,000; Kentucky Coffee Tree, 100; European Oaks, 800; American Chestnut, 25; Hornbeam, 3,128; American Beech, 50; European Beech, 2,000; Turkey Oaks, 350; Mist Tree, 200; American Larch, 200; Green Poplar, 96; Silver Maple, 440.

The City Councils and other officials will be authorized to draw on the above stock of trees, to the extent of the fulfilment of the trusts under the

Digitized by Google

wills of Cresson and Michaux, through the Park Commission, and even beyond those limits no doubt the Commission would consent for the public Squares, streets and Institutions.

Within the Park the Landscape Gardener will exert his skill to blend in beauty the self-sown forests there growing, with artistic planting, as the formation of new avenues and fresh grading will demand; where the new trees will be of kinds not native to our environs, and show in contrast the hand of Art; but at the same time greatly add to the variety and novelty of the trees and plants; so that the trees of the Park shall become a great *Arboretum*, and its flower beds become Botanic Gardens. Thus the landscape formed to please the taste, and the gardens to delight the eye, will become Schools of Science for all scholars and citizens. For this end, each section of the Park will be planted with the largest practicable variety of trees and plants.

That the variety of these may be greatly increased, we have purchased the trees exhibited in Horticultural Garden, and the gathering and planting of acorns and tree seeds have had in view mainly to increase the number of species, while providing the necessary stock whence to transplant trees over our Park of nearly three thousand acres in extent.

It is with pleasure I name those who have afforded the Committee cordial aid in supplying trees, acorns and tree seeds for the Fairmount Park during this Centennial year. They are, Dr. George B. Wood; Dr. George Smith, of Delaware County; Isaac Martin; Thomas S. Chambers; Mr. Smedley; Israel Lamborn, of Chester County; Dr. Kirkbride; Aubrey H. Smith; Philip C. Garrett; Isaac F. Baker; Clarance H. Clark; Dr. Morris Longstreth; Isaac Burke; George Stockham; Burnet Landreth; Thos. L. Craig, of Philadelphia; David Marshall, of San Francisco; Rollo Nichols, of Conn.; and Samuel Davenport, of South Australia, Commissioner to the Centennial Exhibition.

Through the latter the Committee received a collection of tree seeds from Tasmania; and have been informed of others on the way from South Australia. Mr. Davenport hopes to furnish the seeds of a Mountain Eucalyptus, with antimalarial potency, that will stand our climate.

The acorns and tree seeds furnished to the Park Nursery, have been, English White Oak, European Oak, Overcup White Oak, Post Oak, Chestnut White Oak, Weeping Oak, Willow Oak, Spanish Oak Acorns, Red Oak, Scarlet Oak, Pin Oak, White Oak, Turkey Oak, Bartram Oaks.

The American Ivy, Yellow Locust, do., pseudaccasia, Kentucky Coffee tree, Silver Ash, Black Ash, Horse Chestnuts; Larch, European and American; Nettle tree, Paw-paw, Magnolia, Flowering Crab Apple, Carolina and Green Buckthorn, Firethorn, Dogwood, Silver Bell, Winterberry, Blackhaw, Japan Callicarpa Cerulea, Skimmia Japonica; Celastris Scandens; Chinese Bignonia, Laburnums, Horse Chestnuts; White Birch, English Ash, Catalpa, Tulip Tree, Elm, Oriental Plane Trees.

Of Maples, Norway, Sycamore, Purple-leaved, Currant-leaved, Sugar and Rock Sugar.

Digitized by Google

Nor have we failed to think of the boys and girls of future times, and have planted and provided for the planting of the nuts of the Shellbark Hickory, large and small, English and black Walnuts, Chestnuts and Chincopins; the Nutmeg Pine.

Many of the above varieties of acorns and tree seeds have been supplied through Samuel Davenport to four Provinces of Australia, to wit: Victoria, Tasmania, Queensland, and New South Wales; and also to Dr. Schomburgk, of Adelaide, S. A.; to the Phillipine Islands, through Mr. Sebastian Vidal, Spanish Commissioner for the preservation of the forests of those islands; to Japan, through Rev. E. R. Beadle. The supply of acorns and tree seeds has been procured without any cost to any public or trust fund.

The Park Commission have received from Mr. Jacob Hoffner, of Cincinnati, Ohio, a Sago Palm, now in Horticultural Hall, formerly owned by Robert Morris and Henry Pratt, when they owned Lemon Hill, which plant is now supposed to be about 130 years old.

It is in this Centennial year that the artistic planting of the Park has fairly begun; and with the stock of trees on hand in the nursery, with moderate additions for the sake of variety, the formation of the landscapes may steadily proceed, without any serious expenditure, towards completion, as far as such work will admit of completion; for always old trees must decay, to be replaced by those that are both young and new. To fail to meet the annual expenditure for such purpose would be to fail to realize two great purposes of acquiring the Park, namely, the health and enjoyment of the people, and the increase of the resources of taxation commensurately with the interest of the capital invested in the Park. The Park must both be kept beautiful and attractive and the purity of the water supply preserved, or we become delinquent in performing a great duty towards our City, State and Country.

Fault has been found for delay in planting trees in the Park. This complaint is partly to be answered, if not fully, by the fact that it was necessary first to purchase the lands in the Park from many owners, including building lots in six village plots, necessarily a work of time, and after the purchases the ground had to be, and is yet to be, planned, graded, and avenues opened, before it could be known where to plant trees; and the Centennial International Exhibition necessarily caused delay in planning the West Park. There has been such delay during which it is to be regretted trees have not been growing; but that regret will be lessened when we reflect that the planning and planting can now go on rapidly, and be adapted to the buildings and gardens in the exhibition grounds with now an adequate supply of trees at command, and competent skill employed for planning and landscape gardening. These advantages will probably compensate for the loss by delay; and, indeed, more than compensate for them. Let us now proceed with such earnestness that the era of our Park's great improvements shall date from our National Centennial Year.

ELI K. PRICE, *Chairman, &c.*

Digitized by Google

Oil Well Records, selected from the collections of Mr. J. F. Carll, Assistant Geologist in charge of the Geological Survey of the Oil District of Pennsylvania. Communicated by J. P. Lesley, State Geologist.

(*American Philosophical Society, Dec.* 15, 1876.)

I hope to present at another meeting my views of the value of these records, and an analysis of the conclusions arrived at by Mr. Carll from a comprehensive study of many hundreds of such records collected by him during the last three years, since the commencement of the Second Geological Survey of the State in 1874; as well as from his practical experience of operations in the Oil Region since 1865.

The scientific value of well records is indeed limited by many conditions, each of which should be separately considered. But there can be no question of the utility of preserving them from destruction by publishing them in the printed archives of a society like this. Their publication will answer many questions put by men of science abroad and at home; will place at the service of investigators the original data of our own calculations; will invite the intelligence of thoughtful men in the Oil Region to a more careful scrutiny of such data; and above all, will induce many well borers to be more precise and complete in making up future records, and perhaps to communicate them for comparison. In this way only will it be possible to arrive at broad and true answers to moot questions which no one has yet succeeded in satisfactorily answering, except in a very local and unconnected manner.

Technical names and terms ought to be explained to those who have no business at the wells, but such a glossary would be a long one.

The height of each well mouth above the fixed ocean level datum of the Coast Survey should always be given; but it is often wanting, and then the value of the well record becomes comparatively low.

The well records of one locality have been grouped together; but it must be understood that not one in ten has been obtained, and the whole list is therefore but a meagre selection.

The first groups have been obtained from Companies operating in Warren and Venango Counties; others might have been added from Clarion and Butler Counties as specimens of the collections made in those Counties, to be published hereafter to show the geological persistency of the Oil-Sand Group from Tidioute to Butler.

Colorado Well, No. 1.

August 12th, 1870.

Located in Warren County, Southwest Township, Pa. on Pine Creek, or East Oil Creek, between Pleasantville and Tidioute, and two miles northeast of Enterprise.

Level of well mouth above ocean level in feet.*.................					1367
Casing to rock................................	86	to	86	=	1281

* On the provisional assumption that Oil City Depot is 995′ above *mean high tide P. R. R. datum;* and 7′ added for ocean level in Raritan Bay.

Interval of measures unnamed................	236	to	270	=	1097
First Sand (1st S. S.).........................	57	"	327	=	1040
Interval unnamed............................	88	"	415	=	952
Second Sand (2d S. S.).........................	24	"	439	=	928
Interval unnamed............................	81	"	520	=	847
Third Sand (3d S. S.).........................	46	"	566	=	801
Well carried down in "Pocket"..............	9	"	575	=	792

Size of hole 5½″; drilled wet; cased with 3¼″ casing to shut off the water. Seed bag on casing below 2d S. S. say at about 445′.

A "mud vein" 8′ below top of 3d S. S. at 528′.

The oil sand was of uniform color [white and pebbly] with the softest stratum on top, and appearances indicate that nearly if not quite all the oil comes in the well at 5 or 6 feet below the top of the 3d sand, between which points both torpedoes were exploded.

This well was pumped about thirty days, part of the time with a gas pump attached and part of the time without one.* The largest natural production without the gas pump was 4 barrels per day. The first day after the gas pump was applied the production increased to 6 barrels, from which point it gradually declined to less than 4 barrels.

On the 21st of November, 1870, it was torpedoed at a point 5½ feet below the top of the 3d S. S. It then produced 160 barrels per day for the first few days, but gradually declined to 13 barrels per day by the 1st of June, in the following year, 1871. The gas pump was again tried with no satisfactory results, and taken off as wortbless or of no benefit to the well.

On December 21st, 1871, the production had declined to 10 barrels. A one quart nitro-glycerine torpedo was then exploded in the oil sand, which increased the production to 40 barrels per day. But this continued only a day or two. It immediately commenced decreasing, and on the 1st of August, 1872, about two years from the time it was first pumped, it had declined to its first natural production of 4 barrels per day.

During this month, August, 1872, the "volcanic treatment" was tried upon the well at three different times. The first time 4 burners were used, resulting in a slight increase of gas, but no increase of oil.†

The second time 7 burners were used, same results.

* Every oil well has more or less gas, which, separating from the oil at the bottom of the well rises between the tubing and casing and escapes through a pipe provided for the purpose, at the well mouth. A "gas pump" is an instrument which is attached to this escape pipe to relieve the rising gas from atmospheric pressure and thus facilitate and increase its flow. In many cases it not only augments the flow of gas but very materially improves the oil production of the well. A "Rotary" or "Gas Blower" is sometimes used for the same purpose.

† The "volcanic burner" is a patented article designed to increase the production of a well by intensely heating the fluid at the bottom. It consists of a case filled with chemical ingredients. After lowering it to the desired spot the materials are ignited by an electric spark. The operation is repeated until the desired heat has been obtained, when the tubing is at once put in and pumping resumed.

Digitized by Google

The third time 9 burners were used, same results, leaving the well at the end of the treatment with an appreciable increase of gas, but no improvement in the supply of oil.

A "scratcher" was also used in this well once, but with no benefit.*

By a series of experiments in casing and pumping, the salt water is supposed to come into the well with the oil near the top of the 3d S. S.

Colorado Well, No. 2.

Located on Colorado Oil Tract, 15 rods south of No. 1, and at the same altitude.

Dry cased hole. Salt water in second sand. Cased below second sand. Produced no oil and only about a quarter of a barrel of salt water per day.

Sand rocks about the same thickness as in well No. 1, but the third sand was of inferior quality, very little of it being white.

Colorado Well, No. 3.

August 20th, 1870.

Located 13 rods, N. 78° E., from No. 1.

Level of well mouth above ocean level in feet†					1404
Casing to rock	34	to	34	=	1370
?	279	"	313	=	1091
1st S. S.	44	"	357	=	1047
?	97	"	454	=	950
2d S. S.	21	"	475	=	929
?	84	"	559	=	845
3d S. S	45	"	604	=	800
? pocket.	8	"	612	=	792

Mud vein in 3d S. S. at 566 feet.

Cased at 475 feet.

3d S. S. {
top 6′ gray, with but little white.
next 2′ white and soft (good).
next 20′ white, but close.
bottom 17′ mixed gray and white.

When first pumped it yielded only one barrel of oil per day and continued thus until a "scratcher" was used, which brought the production up to 15 barrels for a few days. It then declined to 4 barrels when a three pint nitro-glycerine torpedo was inserted 6 feet from the top of the third S. S. After this it produced 100 barrels per day for a short time.

* A "scratcher" is a round brush, about three feet long, made of steel wire. When it is to be used the tubing is drawn from the well, a few barrels of benzine are poured in and the scratcher is attached to the sucker rods and run down to the oil rock, where it is worked up and down for some time to scratch or scrub the walls of the well and assist the benzine in the dislodgment of whatever may have accumulated there.

† Oil City Depot provisionally 995 + P. R. R. datum.

Digitized by Google

The use of benzine in this well gave no satisfactory results, probably on account of salt water.

Three pint torpedo exploded 8 feet below top of 3d sand, May 30th, 1872. Daily production increased to 10 barrels, but declined to 5 barrels in 10 days. Torpedoed again, Dec. 18th, 1872. Result not stated.

Colorado Well, No. 4.

August 20th, 1872 (?).

Located 5½ rods S. E. of McKinney's N. E. corner.

Level of well mouth 26′ lower than No. 1*					1341
Drive pipe to rock	31	to	31	=	1310
?	205	"	236	=	1105
1st S. S.	45	"	281	=	1060
?	109	"	390	=	951
2d S. S.	21	"	411	=	930
?	84	"	495	=	846
3d S. S.	43	"	538	=	803
? pocket.	6	"	544	=	797

Drilled dry. Cased at 413 feet.

Best natural production, 2 barrels per day.

The hole was dry when the 3d sand was struck, and remained so until the drill had penetrated the 3d sand 5½ feet. At this point oil and salt water came in. The best part of the sand was from 505 feet to 515 feet; below this the sand was poor.

The first	torpedo	was exploded	5	feet	below	top of rock.	
" second	"	"	10	"	"	"	
" third	"	"	5	"	"	"	
" fourth	"	"	15	"	"	"	May 4th, 1872.

The production was increased by the first torpedo but soon settled back to about 5 barrels per day. The same effect followed the second and third. The fourth was a one quart nitro-glycerine blast, but it made very little increase in the oil flow. Benzining, flooding the sandrock with oil, and "scratching" the walls, all failed to produce beneficial results.†

* Oil City Depot provisionally 995′ + P. R. R. datum.

† A well is "flooded" by pouring sufficient fluid in at the top, while the pump remains idle, to fill up the shaft several hundred feet, more or less, above the oil sand. Benzine and crude oil are both used for this purpose: the object being to saturate the rock, under pressure, in order that the paraffin or other accumulations which may have adhered to its surface or obstructed its pores may be loosened and removed with the fluid when the pump is again started.

Digitized by Google

Colorado Well, No. 5.

Struck about August, 1871.

Located 14 rods south of No. 4.

Level of well mouth above ocean level, No. 1 + 31′ =*.........					1398
Drive pipe to rock..........................	70	to	70	=	1328
1st and 2d Sands and intervening measures "regular" to top of 3d S. S..............	423	"	493	=	905
3d S. S....................................	43	"	536	=	862
? ....pocket.	7	"	543	=	855

Wet hole. Cased at 217 feet. Crevice in 3d sand 11 feet below the top.

Natural production 60 barrels per day at commencement, but declined quite rapidly to 15 barrels. Remained thus for some time until torpedoed when it declined to 10 barrels.

First torpedo exploded 5 feet below top of 3d S. S.
Second " " 11 " " "
Third " " 5 " " "
Fourth " " 26 " " "

The production steadily declined; no beneficial results following the use of any of the torpedoes, except a slight temporary increase from the last.

The volcanic treatment was also tried without any marked effect.

The 3d sand was better than the average sands of other wells drilled in this neighborhood. The best and softest stratum commenced 3 feet below the top of the rock and continued to 7 feet. From 11 feet downward to the bottom of the rock the sand was good, but not as soft as in the upper division.

Colorado Well No. 6.

August 16th, 1871.

Level of well mouth above ocean*...........				
Casing to rock..............................	32 feet.		32	=
?...	318	to	350	=
1st S. S..................................	40	"	390	=
?...	107	"	497	=
2d S. S....................................	19	"	516	=
?...	81	"	597	=
3d S. S....................................	46	"	643	=
? ....pocket.	8	"	651	=

Wet hole, cased at 516.

Third sand very close and hard. Natural production less than 1 barrel per day.

First torpedo exploded 7 feet below top of 3d S. S. Production increased to 10 barrels but soon declined to 5 barrels.

Second torpedo 6 feet lower. Increase to 10 barrels but for shorter time than the first.

Scratched, with no benefit.

* Oil City Depot provisionally 935′ + P. R. R. datum + 7 for ocean level.

Digitized by Google

Third torpedo, May 8th, 1872, 7 feet lower than the second. Slight increase in oil.

Fourth torpedo, July 13th, 1872. 5 feet below top of 3d S. S., and 2 feet above the point at which the first was exploded. Increased production but did not pay for cost of torpedoing.

Abandoned August 2, 1872.

Colorado Well No. 7.

Struck August 8th, 1871.

Level of well mouth above ocean............................

Drive pipe to rock............................	75 feet.		75	=
?..	190	to	265	=
1st S. S....................................	25	"	290	=
?..	79	"	369	=
2d S. S....................................	15	"	384	=
?..	96	"	470	=
3d S. S....................................	43	"	513	=
?..................................pocket.	8	"	521	=

Wet hole. Cased at 386.

Mud vein 12 feet below top of 3d S. S. Natural production 7 barrels per day for a few days.

Third sand poor. From marks of oil on the tubing while the well was being pumped, it was inferred that the oil came in at a point in the sandrock just under the "mud vein," say from 12 to 15 feet below the top of the sand.

A three pint nitro-glycerine torpedo was discharged at the point in the sandrock where the oil appeared to come in. The production rose at once to 40 barrels per day, but declined rapidly to 20 barrels and then slowly to 17 barrels, at which figures it remained for more than three months, when it was flooded with water from well No. 10, then drilling within 15 rods of No. 7. When No. 10 was completed and tubed, and the water in it partially exhausted, this well, No. 7, began to recover its oil, but not in so large quantities as before it was flooded. From the time No. 10 began to pump oil, in January 1872, until July of the same year, No. 7 slowly declined in production and at the latter date was pumping only 2 barrels per day.

It was then torpedoed again at the same point as at first, after which it yielded, for a short time, 25 barrels per day and then declined rapidly to 4 barrels.

During the great "shut down movement of October, 1872," when all the walking-beams in the Oil Regions were stopt for 30 days, this well lay idle. But on starting up again in November, it produced 40 barrels per day for three days. Seven days later it was producing 8 barrels, and at the end of one month had settled to its old production before the "shut down," say 4 barrels.

Digitized by Google

Colorado Well No. 8.

Struck November, 1871.

Level of well mouth above ocean					
Casing to rock	10 feet.		10	=	
?	268	to	278	=	
1st S. S	30	"	308	=	
?	102	"	410	=	
2d S. S	20	"	430	=	
?	85	"	515	=	
3d S. S	46	"	561	=	
? ...pocket.	4	"	565	=	

Drilled dry. The casing was first put in at 180 feet. Failing to shut off the fresh water, it was drawn and the large hole continued down to 278 feet. At this point it was cased again, but both fresh water and salt water came in below as the drill went down, and the casing had to be drawn the second time. The well was then reamed down to the second sand, and 432 feet of casing put in, after which the hole remained perfectly dry until the oil sand was reached.

The upper 20 feet of the 3d S. S. was good. The lower (26 feet) was finer, of a grayish color and intermixed with white pebbles. When the 3d S. S. was struck, gas came in very freely and the hole quickly filled up many feet with oil and salt water.

Natural production 1½ barrels per day.

Torpedoed November 21, 1871 with 2 quarts of nitro-glycerine. Exploded 6 feet below top of 3d S. S. Result, 7 barrels per day. Declined rapidly.

Torpedoed December 15, 1871 with 3 pints of nitro-glycerine. Exploded at top of 3d. S. S. Result, not satisfactory.

Torpedoed May 2, 1872 with 1 quart nitro-glycerine. Exploded 15 feet below top of 3d S. S. Result, slight improvement.

Abandoned November 7, 1872.

Colorado Well, No. 9.

November, 1871.

Level of well mouth above ocean*					1508
Conductor to rock	18 feet.		18	=	1490
?	395	to	413	=	1095
1st S. S	28	"	441	=	1067
?	119	"	560	=	948
2d S. S	25	"	585	=	923
?	77	"	662	=	846
3d S. S	48	"	710	=	798
? ...pocket.	6	"	716	=	792

Drilled dry. Cased at 417½ feet.

Sand generally good.

Natural production about 3 barrels for a short time.

* Oil City Depot provisionally 995′ + P. R. R. datum.

Digitized by Google

Nov. 29th, 1871. A two quart torpedo was used 11 feet below top of 3d S. S. Result, 10 barrels per day at first, with rapid decline.

Dec. 11th. A two quart torpedo was exploded at 6 feet in the sand. Result not as satisfactory as from the first one. On May 21, 1872, the production had decreased to less than 2 barrels per day. A 3 pint torpedo was then put in 17 feet below the top of the sand. Production for the next four months, 4 barrels per day. After the "30 days shut down" of Oct. 1872, it started to pump at less than 1 barrel per day, and with very little gas. This decline was attributed to the pumping of the wells on the adjoining tract after this one had been stopt.

Nov. 26th, 1872, it was treated with 6 volcanic burners, but with very slight improvement.

Dec. 7th, 1872, exploded a 3 pint torpedo 20 feet below the top of sand. Increase in oil very slight.

June 24th, 1873. Production, half barrel per day.

Colorado Well, No. 10.

January 10th, 1872.

Level of well mouth above ocean				
Drive pipe	42 feet.		42	=
?	198	to	240	=
1st S. S	40	"	280	=
?	89	"	369	=
2d S. S	14	"	383	=
?	87	"	470	=
3d S. S	43	"	513	=
? pocket.	9	"	522	=

Wet hole. Cased at 274 feet, 3¼ inch casing.

3d sand of ordinary quality.

Best part of it between 482 feet and 485 feet. This well when first pumped threw off a large quantity of fresh water, and then gradually changed to salt water. The first eight days of pumping the yield of oil did not exceed 3 barrels per day. On the tenth day it produced about 100 barrels of oil, and an equal quantity of salt water. It continued to do the same with but very little variation for four months, after which it slowly declined to 60 barrels of oil, and 60 barrels of salt water. It then declined rapidly to 28 barrels of oil and very little salt water. On the 27th of November, 1872, when the oil flow had declined to 23 barrels, the well was treated with 8 volcanic burners which increased the oil to 30 barrels per day, and also augmented the volume of water. After this, until about June 1st, 1873, the production of oil fluctuated from 22 barrels to 36 barrels per day. It then suddenly declined to 12 barrels per day, with a very perceptible increase of salt water.

Digitized by Google

Colorado Well, No. 11.

January 20th, 1872.

Level of well mouth above ocean*...........................					
Wooden conductor to rock....................	17	feet.	17	=	
?....................................	380	to	397	=	
1st S. S..................................	30	"	427	=	
?....................................	117	"	544	=	
2d S. S..................................	25	"	569	=	
?....................................	76	"	645	=	
3d S. S..................................	46	"	691	=	
?...............................pocket.	8½	"	699½	=	

Drilled dry. Cased at 392½ feet.

3d sand good in every part, particularly so between 662 feet and 670 feet.

Natural production 190 barrels daily for five days. Decreased rapidly to 130 barrels, and then more gradually until Sept. 11th, 1872, when it was pumping only 8 barrels. At this time a 3 pint torpedo was put in. 18 feet below the top of the 3d S. S., resulting in a daily production of 150 barrels for three days. It declined rapidly. On Sept. 21st, it had fallen to 24 barrels per day, and on Jan. 1st, 1873, to 4 barrels per day. A 3 pint torpedo was then used 12 feet in the sand, and the yield was thus brought up to 15 barrels per day for a short time.

Then commenced another rapid decline carrying the production down to 3 barrels per day by the 6th of May following, when another torpedo was inserted, resulting in a slight increase of oil.

On June 24th, 1873, while pumping 4 barrels per day, an attempt was made to fill up the well by putting oil and water in at the top. After 275 pails full had been poured in, it was ascertained that it had only filled up the bottom of the 5½ inch well hole 25 feet.

Colorado Well, No. 12.

March, 1872.

Level of well mouth above ocean*...........................					1335
Drive pipe to rock..............................	57	feet.	57	=	1268
?....................................	198	to	255	=	1070
1st S. S..................................	40	"	295	=	1030
?....................................	90	"	385	=	940
2d S. S..................................	12	"	397	=	928
?....................................	87	"	484	=	841
3d S. S..................................	48	"	532	=	793
?...............................pocket.	13	"	545	=	780

Drilled dry. Cased at 220 feet.

* Oil City Depot provisionally 995' + P. R. R. datum.

Digitized by Google

Best part of oil sand from 492 feet to 504 feet. Oil came in while running the second "bit" after the 3d sand was struck.*

Natural production 80 barrels per day, when first struck, declining slowly to 7 barrels by the 20th of August, 1872, when a 3 pint torpedo was put in 10 feet below the top of 3d sand. The result was an increase to 60 barrels the first 24 hours and a rapid decline to 10 barrels in 30 days. For two or three months after this it pumped steadily 10 barrels per day, and then began to decline. On May 24th, 1873, it was yielding only 3 barrels per day. Another torpedo was now exploded at a point 14½ feet below the top of the 3d S. S., bringing the production up to 30 barrels per day for two days, followed by a gradual decline to 10 barrels at the end of 30 days.

Colorado Well, No. 13.

July 20th, 1872.

Level of well mouth above ocean				
Wooden conductor to rock	15 feet.		15	=
?	374	to	389	=
1st S. S	29	"	418	=
?	73	"	491	=
2d S. S	19	"	510	=
?	98	"	608	=
3d S. S	38	"	646	=
Sand and slate alternating	8	"	654	=
Slate	4	"	658	=

Drilled dry. Cased at 205 feet.

Best sand from 3 to 8 feet below the top of 3d S. S. While drilling in this the well filled up rapidly.

Natural production 3 barrels per day. July 26th, exploded a 3 pint torpedo 5 feet below top of 3d S. S., causing but little improvement in production.

Aug. 2d, 1872, exploded another 3 pint torpedo one foot higher in the sand. Increase slight. Five days after torpedoing the well was producing 5 barrels.

Colorado Well, No. 14.

August 1st, 1872.

Level of well mouth above ocean				
Wooden conductor to rock	15 feet.		15	=
?	372	to	387	=
1st S. S	23	"	410	=
?	106	"	516	=

* A "bit" is the technical term applied to the chisel-shape tool used in drilling before the "reamer" or finishing tool is introduced. It is seldom "run" more than three feet without being withdrawn for sharpening. Oil struck "while running the second bit" means, therefore, that it was from three to five feet below the top of the sand rock.

Digitized by Google

2d S. S.	21	to	537	=
?	85	"	622	=
3d S. S.	45	"	667	=
? pocket.	8	"	675	=

Drilled dry. Cased at 275 feet.

Salt water and gas appeared in 2d S. S. Third sand white and soft. Oil and salt water came in at a point 12 feet below its top. The best quality of sand was between 17 and 25 feet. Soft sand from 28 to 30 feet. Indications of a crevice between 38 and 40 feet.

Natural production 2 barrels per day.

Aug. 10th, 1872. Torpedoed (8 pints) at 18 feet below top of sand. Production rose to 14 barrels per day, but declined in 10 days to 8 barrels. Then sank to 6 barrels. Pumped steadily 6 barrels per day for a long time, then slowly began to decline, and on the 26th of June, 1873, it was pumping less than one barrel per day.

Colorado Well. No. 15.

August 25th, 1872.

Level of well mouth above ocean..............................

Wooden conductor to rock	14 feet.		14	=
?	306	to	320	=
1st S. S.	27	"	347	=
?	83	"	430	=
2d S. S.	20	"	450	=
?	97	"	547	=
3d S. S.	38½	"	585½	=
? pocket.	13½	"	599	=

Drilled dry. Cased at 173 feet.

Considerable gas in 2d S. S.

Softest part of 3d S. S. commenced at 3½ feet below its top, and continued down to 7 feet. At this point there was a large amount of gas and the well filled rapidly with fluid, the larger portion of it being salt water. From 14 to 18 feet below the top of the sand, the composition of the rock was such as to warrant the expectation of a good well, but there was so much fluid in the hole at this time that it could not be positively ascertained whether oil came in at this point or not.

Natural production 1½ barrels per day.

Aug. 29th, 1872. Torpedoed (3 pints) at 5 feet below top of 3d sand. Production first 24 hours thereafter, 12 barrels; and ten days later, 10 barrels per day.

Nov. 18th, 1872. Exploded a torpedo shell filled with giant powder, said to equal in strength a 3 pint nitro-glycerine torpedo. Before torpedoing the well was pumping 5 barrels per day. Four days afterwards, it was producing 6 barrels per day. The explosion filled up the well hole 10 feet. [Meaning, no doubt, with the crushed and broken fragments of the sand rock.]

Digitized by Google

This well declined very slowly, and on June 24th, 1873, was pumping 1¾ barrels per day.

Colorado Well No. 16.

November 6th, 1872.

Level of well mouth above ocean..				
Wooden conductor to rock...........................	14	feet.	14	=
?...	406	to	420	=
1st S. S..	20	"	440	=
?...	91	"	531	=
2d S. S..	19	"	550	=
?...	107	"	657	=
3d S. S..	36	"	693	=
?......................................pocket.	14	"	707	=

Drilled dry. Cased at 257½ feet.

Very small quantity of gas and salt water in 2d S. S.

Small quantity of salt water came in at the top of 3d S. S. Oil came in from 7 to 10 feet below the top. Sand good down to 14 feet. Good again from 20 to 23 feet. Below 23 feet it was fine and hard, but white, until near the bottom.

Natural production about 4 barrels of oil and 7 barrels of salt water per day.

Nov. 14th, torpedoed (3 pints) 9 feet below top of 3d S. S., it then produced 7 barrels of oil per day for about 10 days.

May 17th, 1873, pumping 1½ barrels per day. Torpedoed 20 feet below top of sand. Increased to 3 barrels per day for a short time.

June 24th, 1873, pumping 1½ barrels per day and continued to do so until Oct. 17th, 1873. Flooded with 7 barrels of Benzine, but slight increase either in gas or oil.

Nov. 16th, 1863, pumping 2 barrels per day.

Colorado Well No. 17.

November 23d, 1872.

Level of well mouth above ocean..				
Wooden conductor to rock...........................	13	feet.	13	=
?...	396	to	409	=
1st S, S..	21	"	430	=
?...	101	"	531	=
2d S. S..	19	"	550	=
?...	89	"	639	=
3d S. S...................(not through S. S.)	40	"	679	=

Drilled dry. Cased at 287 feet.

Oil came in in small quantities while running the first "bit" in the 3d S. S. First show of salt water about 14 feet below top of sand. Sand soft and white down to 27 feet, then began to change to grey. From 31 feet to 40 feet it was very poor.

Digitized by Google

Natural production 1½ barrels per day. Torpedoed Dec. 3d, 1872 (3 pints), 14 feet below top of 3d S. S., and 48 hours afterward it was producing at the rate of 10 barrels per day.

The well declined very slowly, and on the 26th of June, 1873, it was still producing 4 barrels per day.

Colorado Well, No. 18.

January 25th, 1873.

Level of well mouth above ocean...............................				
Wooden conductor to rock....................	15 feet.		15	=
Interval, containing 1st and 2d S. S............	578	to	593	=
3d S. S......................................	45	"	638	=
?...................................pocket.	11	"	649	=

Drilled dry. Cased at 275 feet.

But little salt water and no oil came into the well until the drill had penetrated the 3d S. S. about 14 feet, here both oil and salt water came in, filling up the hole 75 feet or more. The best and softest part of the 3d S. S. was from 21 to 28 feet below the top of the rock.

Natural production less than one-half a barrel per day.

Torpedoed February 26, 1873 (3 pints), 14 feet below top of 3d S. S. Production brought up to 2 barrels of oil and 10 or 12 barrels of salt water per day. Pumped about four weeks at this rate, then commenced to increase in oil and decrease in salt water, and in ten days was pumping 24 barrels of oil per day. Pumped at this rate for ten or twelve days, then gradually declined, and four months after torpedoing, was pumping 9 barrels daily.

Colorado Well, No. 19.

February 19th, 1875.

Level of well mouth above ocean...............................				
Wooden conductor to rock.........	15 feet.		15	=
Interval, containing 1st and 2d S. S............	514	to	529	=
3d S. S......................................	42	"	571	=
?..	9½	"	580½	=

Drilled dry. Cased at 181 feet.

3d S. S. hard on top but at the depth of 5 feet changed for the better, and some oil and salt water came in. Rock remained quite close until the drill had gone down 13 feet in the sand when it became softer, but still there was no perceptible increase of fluid in the hole. From 13 feet down to 22 feet the sand was rather soft, and remained good down to 33 feet, from which downward it gradually grew finer and harder.

Natural production about 1½ barrels of oil and 12 to 15 barrels of salt water per day.

Feb. 22, 1876, torpedoed (3 pints) 14 feet below top of 3d S. S. After

Digitized by Google

torpedoing it commenced to pump at the rate of 15 barrels per day, and increased gradually, and on

March 1st, it was pumping			30 barrels per day.		
" 20th,	"	"	34	"	"
April 1st,	"	"	28	"	"
" 8th,	"	"	30	"	"
May 10th,	"	"	20	"	"

Colorado Well, No. 20.

April 11th, 1876.

Level of well mouth above ocean..............................				
Drive pipe to rock..............................	41	feet.	41	=
Interval, containing 1st and 2d S. S............	455	to	496	=
3d S. S..............................	44	"	540	=
?..............................pocket.	10	"	550	=

Drilled dry. Cased at 159 feet.

Softest part of 3d S. S. from 5 to 18 feet below the top. Oil began to come in with a very little salt water while drilling between 5 and 8 feet. Quite an increase of salt water at 24 feet. Gradual increase of gas all the way from 5 to 25 feet. Sand very hard at 39 feet, but good at the bottom of the rock.

Natural production 2½ barrels of oil, with about 8 barrels of salt water per day.

April 21st, 1876, torpedoed (3 pints) 8½ feet below top of 3d S. S. Production during the first twenty-four hours thereafter, 7 barrels of oil with not much increase of salt water and a small increase of gas.

May 10th, 1876, pumping 6 barrels of oil per day.

Colorado Well, No. 21.

June 7th, 1876.

Level of well mouth above ocean..............................				
Wooden conductor to rock..............................	10	feet.	10	=
Stove pipe casing*..............................	14	"	14	=
Interval, containing 1st and 2d S. S............	614	"	628	=
3d S. S..............................	41	"	669	=
?..............................pocket.	10	"	679	=

Drilled dry. Cased at 249 feet.

The softest and best part of the 3d S. S. commenced at 2 feet below its

* Sometimes the conductor is not properly driven to the rock. The drilling commences, and after going down some distance it is discovered that the loose material is falling in at its bottom. When the "cave" is not very serious a common, riveted, sheet iron "stove pipe" cylinder is shoved down to prevent its enlargement. This casing is merely a supplement or lining to the conductor, and represents what should have been the length of the conductor had it properly been put in originally.

Digitized by Google

top and continued down to 8 feet. Here oil and gas and salt water came into the hole. The sand was quite soft until the rock had been penetrated 30 feet, after this it was very hard until quite near the bottom, where it was found to be soft and coarse.

Natural production about 5 barrels of oil with 10 barrels of water during the first twenty-four hours. Three days later it was pumping 6 barrels of oil.

June 18th, 1876, pumping about 5½ barrels of oil.

June 20th, 1876, torpedoed (3 pints) 6 feet below top of sand. Result 15 barrels at first, gradually running down to 8½ by Nov. 25th.

Magnolia, No. 1.

Struck June, 1872.

Located on Ware Farm, Colorado District.

Level of well mouth above ocean*					
?	438	to	438	=	
1st S. S	30	"	468	=	
?	122	"	590	=	
2d S. S	10	"	600	=	
?	82	"	682	=	
3d S. S	43	"	725	=	
? ... pocket.	10	"	735	=	

Drilled dry. Cased at 286 feet.

Show of oil at 688, and gas at 696.

3d S. S. rather dark and close.

Production, after one torpedo, about 2 barrels per day.

Pumped at intervals until January, 1873.

Magnolia, No. 2.

Struck July 7th, 1873.

Ware Farm, Colorado District.

Level of well mouth above ocean*					1615
7⅝ inch casing to rock	61	feet.	61	=	1554
?	691	to	752	=	863
3d S. S	42	"	794	=	821
Slate	1	"	795	=	820
Very hard shell	5	"	800	=	815
? ... pocket.	5	"	805	=	810

Drilled dry. Cased at 350 feet.

Best and softest part of 3d S. S. from near the top down to 12 feet. Good sand all the way down to 30 feet. Oil came in while drilling, but could not tell at what point, on account of the accumulation of salt water in the hole, coming down from the 2d S. S.

Natural production between 3 and 4 barrels per day.

* Oil City Depot, provisionally 995′ + P. R. R. datum.

Digitized by Google

July 9th, 1873. Torpedoed (3 pints) 7 feet below top of 3 S. S. Produced about 11 barrels the next 24 hours.

July 12th. Torpedoed (3 pints) 12 feet below top of rock. No increase.

Chick Well, No. 1.

January, 1872.

Colorado District.

Level of well mouth above ocean				
?	598	to	598	=
2d S. S	19	"	617	=
?	85	"	702	=
3d S. S	34	"	736	=
? pocket.	25	"	761	=

"Measured by the drillers; probably incorrect."

Cased with 5⅝″ casing, but failed to shut off the water. Afterwards cased with 3¼″ casing to depth of 450 feet.

3d S. S. about 43 feet thick. Close and dark. Best part of it from 717 to 720 feet. Fair at 734 feet.

Natural production less than one barrel per day.

Torpedoed at 705 feet and 717½ feet. Increased to about 8 barrels per day. The well was pumped by heads, and in January, 1873, produced about 2 barrels per day.

Chick Well, No. 2.

Nov. 15th, 1873.

Colorado District.

Level of well mouth above ocean				
?	0	to	734	=
3d S. S	45	"	779	=

Drilled dry. Cased at ———

Mud vein 5 feet below top of 3d S. S. Sand soft at top. Very good between 12 feet and 20 feet. Salt water at 24 feet.

The well filled up with oil about 200 feet before the salt water vein was struck.

Natural production about 10 barrels per day.

Dec. 3d, 1873, torpedoed 13 feet below top of 3d S. S. Production increased to 60 barrels per day. Declined gradually to 15 barrels by Feb. 15th, 1874.

Torpedoed a second time, resulting in a slight increase of oil for a short time.

Chick Well, No. 3.

February 13th, 1873.

Colorado District.

Level of well mouth above ocean				
Wooden conductor to rock	20 feet.		20	
?	736	to	756	=
3d S. S	52	"	808	=
? pocket.	14	"	822	=

Digitized by Google

Drilled dry. Cased at 378 feet.

Strong flow of gas and oil when 3d S. S. was first struck, and the well filled up nearly 300 feet with oil.

Mud vein about 5 feet below top of 3d S. S. Sandrock rather ordinary for the first 25 feet, below that point quite hard, and at the bottom gray and dark. Softer than usual at 17 feet below the top. Salt water appeared between 25 and 30 feet below the top of sand.

Natural production, 75 barrels of oil and 100 barrels of salt water per day.

June 25th, 1873, the production was 25 barrels per day.

Potter Well, No. 1.

February 3d, 1873.

Colorado District.

Level of well mouth above ocean						
Wooden conductor to rock	25 feet.		25			
?	645½	to	670½	=		
3d S. S	47	"	717½	=		
? pocket.	12½	"	730	=		

Drilled dry. Cased at 266 feet.

3d S. S. good from top to bottom. Soft at 6 feet. Also from 12 to 15 feet, and extra quality at 42 feet. The lower part of the sand was softer than the upper, which is not generally the case in this locality.

The well filled up with fluid nearly 300 feet while drilling, but it was mostly composed of salt water.

Natural production, about 3 barrels of oil and 12 barrels of salt water per day.

Feb. 5th. Torpedoed 12 feet below top of 3d S. S. Bottom of hole filled up one foot with sand. Result, 12 barrels of oil and 50 barrels of salt water per day at first, declining to 6 barrels of oil in four days.

Feb. 10th. Torpedoed 6 feet below top of sand. Well filled up with sand 4 feet. Production slightly increased for a short time.

March 12th. Treated the well with 10 volcanic burners. But slight improvement.

April 2d. Torpedoed 21 feet below top of sand. No benefit.

April 21st, 1873. Abandoned the well.

Potter Well, No. 2.

February 11th, 1873.

Colorado District.

Well mouth above ocean.*					1550
Wooden conductor	15 feet.		15	=	1535
?	663	to	678	=	872
3d S. S	50	"	728	=	822
? pocket.	16	"	744	=	806

Drilled dry. Cased at 264 feet.

* Oil City Depot provisionally 995′ + P. R. R. datum.

Digitized by Google

The 3d S. S. was good all the way through. Uncommonly so, for the first 20 feet, at which depth there was a good show of oil and gas. Below 25 feet the sand was somewhat harder and finer.

Natural production less than one barrel of oil and 8 or 9 barrels of salt water per day.

Feb. 13th. Torpedoed 20 feet below top of 3d S. S. The well filled up with sand 5 feet. Results, good. An increase both in oil and salt water. After several days' delay in getting the well to work, it pumped when first started up 16 barrels of oil and 100 barrels of salt water per day.

March 18th. Treated it with 10 volcanics. Results, an increase of gas and slight increase of oil.

June 20th, 1878, it was pumping 9 barrels of oil and 18 barrels of salt water.

Potter Well, No. 3.

March 21st, 1878.

Colorado District.

Well mouth above ocean*..1549

Wooden conductor to rock	16 feet.		16	=	1533
?..	661	to	677	=	872
3d S. S..................................	50	"	727	=	822
?.................. ....pocket.	8	"	735	=	814

Drilled dry. Cased at 270 feet.

The 3d S. S. was good throughout its entire thickness, soft for the first 24 feet, then somewhat harder, but not very hard in any part.

Natural production 2 barrels of oil and 6 or 8 barrels of salt water per day.

April 9th. Torpedoed (3 pint shell), production increased to 15 barrels of oil per day. Sustained the yield at this point for some time and then slowly declined to 8 barrels by the 20th of June following.

Potter Well No. 4.

March 21st, 1878.

Colorado District.

Level of well mouth above ocean..................................

Wooden conductor to rock..................	19 feet.		19	
?..	637	to	656	=
3d S. S..................................	47	"	703	=
?...............................pocket.	10½	"	713½	=

Drilled dry. Cased at 255 feet.

3d S. S. very uneven. Upper 13 feet soft, next 8 feet very hard, then 3 or 4 feet of soft sand. Below this finer and more even in composition.

Natural production 1 barrel of oil and 15 or 20 barrels of salt water per day.

March 26th. Torpedoed (3 pint shell) 16 feet below top of 3d S. S. Results, an increase to 4 or 5 barrels of oil and 100 barrels of salt water per

* Oil City Depot provisionally 995' + P. R. R. datum.

Digitized by Google

day. Pumped in this way for some time and then gradually increased in oil until it produced 8 barrels per day. A decline then commenced both in oil and salt water. On June 24th, 1873, it had settled back to 5 barrels of oil per day, and on August 6th, to 3 barrels per day. At this time it was torpedoed again, and the next day was pumping at the rate of 8 barrels of oil per day.

On the 21st of August it had run down to 4 barrels per day, with a slight increase in the volume of gas. From this time it gradually declined to 1 barrel per day where it remained for two or three months.

Jan. 22, 1874. Flooded sandrock with benzine with no improvement either to oil or gas.

Jan 28th. Put in one of Quick & Fertig's Injectors.* After the first two injections the production rose to 2½ barrels, increasing to 5 barrels by the end of one week from the time the injector was put in. Benzine was used in the injector; and a gradual increase in production occurred until on July 24th, 1874, the well was pumping 17 barrels of oil per day.

Potter Well, No. 5.

April 4th, 1873.

Colorado District.

Level of well mouth above ocean............................

Wooden conductor to rock....................	16 feet.	16	=	
?..	655	to	671	=
3d S. S....................................	46	"	717	=
?..................................pocket.	11	"	728	=

Drilled dry. Cased at .

3d S. S. good. Upper 35 feet white and soft, then 5 feet of gray and the remaining 6 feet white but hard.

Natural production 2 barrels of oil and 8 to 10 barrels of salt water per day.

April 8th. Torpedoed and brought the production up to 140 barrels of oil per day, but it rapidly declined to 16 barrels, and on June 24th had still further declined to 12 barrels per day. It never pumped much salt water.

Potter Well, No. 6.

June 4th, 1873.

Colorado District.

Level of well mouth above ocean............................

Wooden conductor to rock.................... 18 feet. 18 =

* The "injector" is a patented device by which perforations made in the tubing just above the pump chamber can be opened and closed at pleasure by the "sucker rods." Benzine is poured in at the top of the well and the pump kept in motion until the oil in the well and tubing is pumped out and benzine begins to show at the delivery pipe. The tubing is now full of benzine and the well is empty, or nearly so. On opening the apparatus in the injector, the 500 or 1000 feet of benzine in the tubing forces out strong jets in all directions against the walls of the well washing them down with force and giving more satisfactory results than can be obtained by a simple "flooding" with benzine. The process may be repeated again and again until the desired effect is produced.

Digitized by Google

?..	639	to	657	=
3d S. S....................................	46	"	703	=
?..................................pocket.	12	"	715	=

Drilled dry. Cased at 240 feet.

3d S. S. good to the depth of 32 feet, below that, finer and not so white.

Oil came in near top of the sand and salt water 4 feet below the top.

Natural production 2 barrels of oil with 6 or 8 barrels of salt water per day.

June 6th. Torpedoed and increased the production to 150 barrels of oil daily. Declined in fourteen days to 36 barrels daily.

June 28th, 1875. Torpedoed 6 feet below top of 3d S. S. Result 3½ barrels per day.

Potter Well, No. 7.

July 11th, 1873.

Colorado District.

Level of well mouth above ocean..............................

Wooden conductor to rock....................	16 feet.		16	=
?..	629	to	645	=
3d S. S....................................	46	"	691	=
?..................................pocket.	13	"	704	=

Drilled dry. Cased at 229 feet.

3d S. S. very soft the first 12 feet, soft the next 14 feet and then harder and not so good as the drill approached the bottom. The well filled up with oil very fast after the sand was struck and while the first "bit" was being run in it.

Natural production 8 barrels per day.

July 14. Torpedoed (3 pint shell) 6½ feet below top of 3d S. S. Result, a production of 100 barrels of oil per day.

Nov. 20th, 1874. Production down to ¾ of a barrel per day. Torpedoed (giant powder) 7½ feet below top of sand. No increase in gas and very little in oil.

From July, 1876, until the 11th of October following, this well produced 2 barrels per day, and then, without any treatment whatever, began to increase. On Oct. 25th it was producing 5½ barrels, Nov. 10th, 6¾ barrels, and Nov. 25th, 5½ barrels.

Potter Well, No. 8.

April 27th, 1876.

Colorado District.

Level of well mouth above ocean..............................

Wooden conductor to rock....................	15 feet.		15	=
?..	616	to	631	=
3d S. S....................................	47	"	678	=
?..................................pocket.	10	"	688	=

Drilled dry. Cased at 225 feet.

Digitized by Google

3d S. S. first 4 feet very hard, next 8 feet very soft; then 9 feet a little firmer but not hard; then 10 feet softer; the remaining 16 feet being about an average sand. The first show of oil was at 21 feet below the top of the sand. Very little salt water and gas came into the hole while drilling, and when the well was tubed there was not more than 20 feet of fluid in it.

Natural production less than ½ of a barrel of oil with about 5 barrels of salt water per day.

The first torpedo exploded 18 feet below top of sand increased the salt water slightly but not the oil and gas.

May 8th. Second torpedo (3 pint shell) 6 feet below top of sand. No improvement.

May 11th. Employed the scratcher. No improvement.

May 12th. Torpedoed 30 feet below top of sand. No increase either in oil or gas.

June 6th. Put in Quick & Fertig's injector. Still no improvement.

The well was abandoned June 22d, 1876, after having been pumped steadily for nearly two months.

Darling Well.

Drilled in 1865.

Gilson Run, Warren County.

Level of well mouth above ocean............................

Drive pipe..................................		57½	feet.
Soft slate..................................	at	70	"
Very hard slate and 3 inch crevice...........	"	78	"
20 inch of salt water....................	"	145	"
Soft slate, 15 inch crevice..................	"	175	"
Very fine sandrock..........................	"	185	"
12 inch crevice..........................	"	230	"
Some oil, 15 inch crevice................	"	290	"
Bottom of sandrock..........................	"	310	"
Grey sandrock..............................	"	355	"
Water course carrying away everything from the well..................................	"	378	"
Some oil, 15 inch crevice................	"	399	"
Fine white sand............................	"	411	"
Bottom of Sand.............................	"	426	"
Flint and slate.............................	"	450	"
Top of sandrock............................	"	514	"
Coarse white pebble sand, 6 inch crevice.....	"	522	"
Pebble rock and bottom of well.............	"	541	"

This well was never cased. The water was shut off by seed bag on tubing. It was pumped some time, producing several barrels of oil which is supposed to have come from the 2d S. S.

Digitized by Google

Clifton Well, No. 1

April, 1872.

Colorado District, southeast corner of tract 200.

Level of well mouth above ocean				
?	0	to	402	=
1st S. S., (estimated)	20	"	422	=
?	123	"	545	=
2d S. S.	19	"	564	=
?	84	"	648	=
3d S. S.	42	"	690	=

Drilled dry. Cased at 264 feet.

Very poor sand. Well never tubed.

Eclipse Wells.

Colorado District.

Level of well mouth above ocean				
6¼ inch casing to rock	48	feet.	48	=
Mountain sand	162	to	210	=
?	240	"	450	=
1st S. S. (estimated)	20	"	470	=
?	55	"	525	=
2d S. S. (estimated)	10	"	535	=
?	45	"	580	=
3d S. S. (estimated)	20	"	600	=
?	76	"	676	=
4th S. S.	29	"	705	=
? pocket.	12	"	717	=

Cadwell Well.

Hill Farm, Colorado District.

Level of well mouth above ocean				
6¼ inch casing to rock	36	to	36	=
?	230	"	266	=
1st S. S.	29	"	295	=
?	105	"	400	=
2d S. S.	18	"	418	=
?	83	"	501	=
3d S. S.	46	"	547	=
? pocket.	4	"	551	=

Wet hole. Cased (8¼ inch) at 275 feet.

Abandoned Dec. 30th, 1875.

Onondaga Well.

East of Enterprise; Colorado District.

Level of well mouth above ocean				
Drive pipe	62	feet.	62	=

Digitized by Google

?	137	to	199	=
S. S. gray	25(?)	"	224	=
?	236	"	455	=
2d S. S.	15	"	470	=
?	51	"	521	=
3d S. S.	13	"	534	=
?	36	"	570	=
4th S. S.	15	"	585	=
?	90	"	675	=
5th S. S.	26	"	701	=
Soft measures. No sandstone	99	"	800	=

Enterprise, Warren County.

Benedict Estate Wells, copied from office records.

Benedict Estate Well, No. 1.

Level of well mouth above ocean

?	192	to	192	=
1st S. S.	50	"	242	=
?	58	"	300	=
2d S. S	4	"	304	=
?	31	"	335	=
3d S. S.	10	"	345	=
?	117	"	462	=
4th S. S.	15	"	477	=

Willard Well, No. 1.

Level of well mouth above ocean

Upper measures not noted	443	to	443	=
3d S. S.	25	"	468	=

Harvey Well, No. 1.

Level of well mouth above ocean

?	180	feet.	180	=
1st S. S.	49	to	229	=
?	71	"	300	=
2d S. S.	6	"	306	=
?	16	"	322	=
3d S. S.	12	"	334	=
?	95	"	429	=
4th S. S.	6	"	435	=
?	14	"	449	=
5th S. S., oil	15	"	464	=

McKinney Well, No. 1.

Level of well mouth above ocean

Upper measures not noted	441	to	441	=
3d S. S.	21	"	462	=

Digitized by Google

Reed Well.

Adjoining Benedict Estate. Record from memory of driller.

Level of well mouth above ocean					
?	150	feet.	150	=	
1st S. S	52	to	202	=	
Slate, blue	118	"	320	=	
2d S. S	14	"	334	=	
S. S., hard, gray	12	"	346	=	
Slate, black	99	"	445	=	
Stray S. S., gray	12	"	457	=	
Slate	12	"	469	=	
3d S. S. [doubtful whether 12 or 22]	22	"	491?	=	

Tidioute and Warren Oil Co.

Dennis Run between Triumph and Tidioute.
Records furnished by Major Cushing, of Tidioute.

Lease No. 58. *Well No.* 1.

Well mouth above ocean*					(?) 1230
?	45	to	45	=	1185
1st S. S	30 (?)	"	75?	=	1155
?	62	"	137	=	1093
2d S. S	25 (?)	"	162?	=	1068
?	133	"	295	=	935
Stray S. S	47	"	342	=	888
? pocket.	8	"	350	=	880
Depth of well					

Well No. 2.

Level of well mouth above ocean					
?	124	to	124	=	
1st S. S	29	"	153	=	
?	63	"	216	=	
2d S. S	28	"	244	=	
?	26	"	270	=	
Stray S. S	16	"	286	=	
?	90	"	376	=	
3d S. S	48	"	424	=	

Well No. 3.

Level of well mouth above ocean					
?	180	to	180	=	
1st S. S	30	"	210	=	
?	60	"	270	=	
2d S. S	35	"	305	=	
?	35	"	340	=	

* Oil City Depot provisionally 995′ + P. R. R. Datum.

Digitized by Google

Stray S. S.	25	to	365	=
?	60	"	425	=
3d S. S.	50	"	475	=

At 436 first show of oil; at 445 second show of oil.

Well No. 4.

Level of well mouth above ocean				
?	320	to	320	=
1st S. S.	35	"	355	=
?	55	"	410	=
2d S. S.	35	"	445	=
?	27	"	472	=
Stray S. S.	13	"	485	=
?	82	"	567	=
3d S. S.	27	"	594	=

Well No. 5.

Level of well mouth above ocean				
?	332	to	332	=
1st S. S.	47	"	379	=
?	44	"	423	=
2d S. S.	35	"	458	=
?	29	"	487	=
Stray S. S.	13	"	500	=
?	84	"	584	=
3d S. S.	48	"	632	=

Triumph Oil Co.

Triumph, Warren Co. From books in office of Company.

Well No. 28.

Level of well mouth above ocean					
?		660	to	660	=
3d S. S. 79 feet.	Fine hard sand	30	"	690	=
	Medium "	13	"	703	=
	Good "	17	"	720	=
	Pebble, (crevice at 722½)	10	"	730	=
	Good sand	9	"	739	=

Well No. 101.

Level of well mouth above ocean				
?	662	to	662	=
3d S. S.	88	"	750	=
? pocket.	6	"	756	=

Sand very good.

Digitized by Google

Well No. 146.

Level of well mouth above ocean				
?	694	to	694	=
3d S. S	96	"	790	=

Coarsest from 764 to 774.
Salt Water at 778.

Well No. 148.

Level of well mouth above ocean				
?	712	to	712	=
3d S. S	103	"	815	=

Coarsest sand at 795 feet.
Mud at 732, 765 and 785.

Well No. 149.

On highest point of hill.

Level of well mouth above ocean					
?		729	to	729	=
3d S. S. 74 feet.	Pebble	2	"	731	=
	Coarse sand	1	"	732	=
	Medium "	2	"	734	=
	Pebble	20	"	754	=
	Coarse sand	10	"	764	=
	Pebble	20	"	784	=
	Coarse sand	12	"	796	=
	Pebble	4	"	800	=
Medium sand		8	"	808	=
?	pocket.	6	"	809	=

Well No. 152. *B.*

Level of well mouth above ocean				
?	712	to	712	=
3d S. S	90	"	802	=
? ... pocket.	3	"	805	=

Upper 60 feet fine.
Lower 30 feet coarse.

Well No. 224.

Level of well mouth above ocean				
?	675	to	675	=
3d S. S	107	"	782	=
? ... pocket.	3	"	785	=

Good sand at 759.
Pebble at 782.

Digitized by Google

Well No. 237.

Level of well mouth above ocean					
?		667	to	667	=
3d S. S. 106 feet.	Fine sand	56	"	723	=
	Very coarse pebble	20	"	743	=
	Fine sand	10	"	753	=
	Grayish pebble	20	"	773	=
?	pocket.	3	"	776	=

Mud at 701 and 710.
Salt water at 747.

Rising Sun Well.

Dennis Run. From S. Minor.

Level of well mouth above ocean				
?	104	to	104	=
1st S. S.	30	"	134	=
?	61	"	195	=
2d S. S.	28	"	223	=
?	117	"	340	=
3d S. S.	28	"	368	=

There was a gray rock about 20 feet below the 2d S. S., and sometimes 25 feet thick. All the rocks were very hard.

Dennis Run.

Wells of J. & E. W. Parshall on tract of N. Y. and Allegheny Oil Co., Dennis Run, near Tidioute. Furnished by Mr. Parshall.

Well No. 4.

Level of well mouth above ocean				
?	320	to	320	=
1st S. S., estimated	30	"	350	=
? (including 2 S. S.)	230	"	580	=
3d S. S.	36	"	616	=
? pocket.	5	"	621	=

Well No. 5.

Level of well mouth above ocean				
?	330	to	330	=
1st S. S., estimated	30	"	360	=
? including 2d S. S.	230	"	590	=
3d S. S.	40	"	630	=

Well No. 7.

Level of well mouth above ocean				
?	240	to	240	=
1st S. S., estimated	30	"	270	=
? including 2d S. S.	222	"	492	=

Digitized by Google

3d S. S.	50	to	542	=
? ....pocket.	5	"	547	=

Well No. 9.

Level of well mouth above ocean				
? ....including 1st S. S.	301	to	301	=
2d S. S., estimated	25	"	326	=
?	115	"	441	=
3d S. S.	66	"	507	=
? ....pocket.	6	"	513	=

Well No. 10.

Level of well mouth above ocean				
?	224	to	224	=
1st S. S., estimated	30	"	254	=
? ....including 2d S. S.	208	"	462	=
3d S. S.	69	"	531	=
? ....pocket.	23	"	554	=

Well No. 12.

Level of well mouth above ocean				
?	255	to	255	=
1st S. S,, estimated	30	"	285	=
? ....including 2d S. S.	233	"	518	=
3d S. S.	82	"	600	=
? ....pocket.	20	"	620	=

Dennis Run Tract. E. W. Parshall's Wells.

Well No. 1.

Level of well mouth above ocean				
?	110	to	110	=
Mountain S. S.	37	"	147	=
?	151	"	298	=
1st S. S.	43	"	341	=
?	89	"	430	=
2d S. S.	30	"	460	=
?	91	"	551	=
3d S. S.	36	"	587	=
?	15	"	602	=

Well No. 2.

Level of well mouth above ocean				
?	73	to	73	=
Mountain S. S., estimated	35	"	108	=
?	153	"	261	=

Digitized by Google

1st S. S., estimated	40	to	301	=
?	88	"	389	=
2d S. S., estimated	30	"	419	=
?	95	"	514	=
3d S. S.	50	"	564	=

Well No. 3.

Level of well mouth above ocean				
? including Mountain S. S.	274	to	274	=
1st S. S.	32	"	306	=
? including 2d S. S.	221	"	527	=
3d S. S.	50	"	577	=

Richardson, Tidioute. East side of Allegheny River. From Messrs. Rallston & Harrington.

Well No. 1.

Situated half way down the hill.

Level of well mouth above ocean				
?	84	to	84	=
1st S. S.	24	"	108	=
?	29	"	137	=
2d S. S.	23	"	160	=
?	76	"	236	=
3d S. S.	9	"	245	=

Well No. 2.

Up the hill.

Level of well mouth above ocean				
?	310	to	310	=
1st S. S.	20	"	330	=
?	24	"	354	=
2d S. S.	24	"	378	=
?	71	"	449	=
3d S. S.	11	"	460	=

NOTES.

In drilling an oil well, the measures passed through are necessarily divided into three groups or divisions. Each one of these divisions requires a specific treatment at the hands of the driller.

The first division is composed of Drift or the loose surface accumulations from the surrounding rocks; the second embraces the immediately underlying series of stratified rocks to the depth at which they contain water; and the third, the remainder of the well, including the oil sands at the bottom. The walls of the third division are generally self-supporting, remaining just as the drill leaves them, and this division, when the well is completed, is the only one where the rocky walls are bare.

Digitized by Google

The first division, owing to the loose and crumbling material of which it is composed, requires some mechanical device to prevent it from slipping or caving into the hole as it is drilled. Here the "conductor" is used A "conductor" may be simply a long box, without ends, made by spiking together four planks 2″ thick by 10″ wide—a "wooden conductor;" or it may be "drive pipe," composed of a number of cast-iron cylinders joined together and driven through the deposit; or it may be what is now more generally used, wrought-iron "surface casing," put in in a somewhat similar manner.

The "wooden conductor" can only be economically used where the surface deposit is of inconsiderable depth, as a pit must be sunk to the rock before it can be put in place. After the rock has been laid bare by the pick and shovel, the "conductor" is securely set between it and the derrick floor, the drill is let down to the rock through the conductor and the work of boring commences.

Where it is suspected that the floor of the Drift lies too deep to be reached by digging, cast-iron "drive pipe" is used. This pipe is cast in sections about 9′ long. A space of 4″ at each end is carefully turned in a lathe to a certain gauge, and the end is cut smoothly at right angles to the axis of the pipe, so that the joints will stand perpendicularly one upon the other. A joint of pipe is placed on end in the centre of the derrick between two "guides" which have been temporarily erected for the purpose of driving it. A heavy "mall" working between these guides is raised and dropped upon the pipe, slowly forcing it into the ground, precisely as piles are driven for docks, bridges, &c. When the top of a joint has been driven to the level of the derrick floor, a band of wrought-iron, made to fit the turned ends of the pipes and heated red-hot, is quickly slipped upon the end of the driven pipe and another joint at once set up. The contraction of this band in cooling holds the two joints firmly together and the driving process then goes on. In this way joint after joint is added and driven until solid rock is reached. As many as 23 joints have been used in a well. Great care is required when so long a "string of pipe" is driven to keep it straight and perpendicular, a broken band, or a large boulder encountered may cause the pipe to so far deviate from the perpendicular as to necessitate the abandonment of the well. To avoid this the pipe should be frequently cleaned out by the drill while being driven.

The more common method now employed in driving the well shafts through these thick accumulations of loose materials, is to use heavy wrought-iron casing, made expressly for the purpose and armed with a hardened collar or "shoe," at the bottom. This casing is made in joints about 20′ in length, which screw together in wrought-iron "thimbles," the same as do ordinary gas pipes. The tube being thin and light as compared with cast-iron drive pipe, cannot be so forcibly driven, but is worked down carefully by drilling a hole the full size of its inside diameter, and always keeping this hole open some feet in advance of the bottom of the pipe. In

(*Continued on page* 378.)

Digitized by Google

Columbia Farm (Old Story Farm,) on Oil Creek, one mile below Petroleum

Name of Well.	Depth of Conductor.	Rock Interval.	First Sand. Top.		First Sand. Bottom.	Rock Interval.	Second Sand. Top.		Second Sand. Bottom.
Babcock..	36	304	340	50	390	52	442	25	467
Stewart...	18	276	294	39	333	103	436	26	462
Reiter....	18	399	417	47	464	74	538	25	563
Jones.....	27	292	319	37	356	105	461	24	485
Blocher ..	30	207	237	28	265	105	370	23	393
No. 58..	27	313	340	33	373	72	445	36	481
" 59..	18	282	300	19	319	124	443	21	464
" 61..	21	458	479	21	500	101	601	23	624
" 62..	27	270	497	32	529	73	602	34	636
" 64..	27	498	525	30	555	82	637	33	670
" 66..	18	518	536	31	567	101	668	23	691
" 69..	24	528	552	27	579	85	664	31	695
" 70..	24	146	170	29	199	111	310	27	337
" 71..	27	502	529	44	573	107	680	20	700
" 72..	18	272	290	35	325	105	430	40	470
" 73..	18	262	280	35	315	102	417	18	435
" 74..	18	257	275	30	305	105	410	27	437
" 77..	36	483	519	42	561	97	658	22	680
" 78..	18	487	505	25	530	123	653	22	675
" 80..	27	525	552	35	587	107	694	24	718
" 81..	18	322	340	45	385	100	485	30	515
" 82..	18	312	330	40	370	115	485	25	510
" 85..	27	258	285	55	340	95	435	20	455
" 86..	36	304	340	50	390	85	475	25	500
" 87..	45	315	360	32	392	98	490	24	514
" 89..	18	262	280	30	310	135	445	24	469
" 90..	18	287	305	50	355	105	460	20	480
" 91..	18	269	287	57	344	115	459	22	481
" 94..	54	171	225	20	245	120	365	33	398
" 96..	18	382	400	40	440	85	525	39	564
" 97..	45	290	335	50	385	103	488	20	508
" 99..	27	508	535	45	580	105	685	20	705
" 100..	27	375	402	53	455	84	539	15	554
" 101..	26	354	380	50	430	101	531	24	555
" 103..	27	283	310	40	350	90	440	41	481
" 104..	27	438	465	50	515	92	607	24	631
" 105..	18	339	357	53	410	90	500	27	527
" 106..	27	482	509	50	559	100	659	25	684
" 107..	27	281	308	40	348	102	450	26	476
" 108..	18	527	545	31	576	103	679	72	751
" 109..	9	521	530	40	570	110	680	30	710

Digitized by Google

Centre, Venango Co. Pa. From the books of the Columbia Oil Company.

Rock Interval.	Stray Sand. Top.		Stray Sand. Bottom.	Rock Interval.	Third Sand. Top.		Third Sand. Bottom.	Pocket.	Feet Depth.
76	543	30	573	20	593	50	643	10	653
58	520	30	550	21	571	53	624	3	627
49	612	30	642	20	662	54	716	6	722
68	553	30	583	20	603	51	654	3	657
76	469	31	500	10	510	52	562	8	570
39	520	32	552	20	572	43	615	3	618
46	510	30	540	19	559	53	612	6	618
53	677	33	710	21	731	49	780	15	795
44	680	30	710	19	729	41	770	11	781
53	723	30	753	17	770	40	810	0	810
63	754	32	786	18	804	46	850	0	850
52	747	34	718	12	793	39	832	5	837
60	397	33	430	17	447	45	492	3	495
54	754	30	784	21	805	40	845	5	850
37	507	25	532	30	562	42	604	0	604
74	509	33	542	14	556	50	606	0	606
69	506	30	536	15	551	37	588	7	595
78	758	28	786	12	798	45	843	0	843
54	729	31	760	15	775	40	815	6	821
67	785	27	812	18	830	36	866	2	868
53	568	31	599	19	618	34	652	3	655
40	550	33	583	17	600	38	638	3	641
45	500	33	533	22	555	40	595	3	598
51	551	29	580	20	600	45	645	3	648
54	568	30	598	21	618	50	668	3	671
46	515	31	546	20	566	39	605	5	610
53	533	26	559	15	574	38	612	3	615
64	545	29	574	12	586	37	623	4	627
49	447	33	480	20	500	40	540	5	545
52	616	27	643	12	655	33	688	2	690
50	558	30	588	22	610	50	660	5	665
52	757	28	785	24	809	41	850	3	853
73	627	30	657	18	675	50	725	2	727
63	618	33	651	17	668	30	698	3	701
71	552	21	573	17	590	50	640	2	642
60	691	26	717	19	736	50	786	5	791
45	572	30	602	35	637	40	677	1	678
53	737	30	767	17	784	50	834	5	839
64	540	29	569	16	585	54	639	3	642
33	784	27	811	13	824	44	868	2	870
65	775	27	802	13	815	39	854	1	855

Digitized by Google

Name of Well.	Depth of Conductor.	Rock Interval.	First Sand. Top.		Bottom.	Rock Interval.	Second Sand. Top.		Bottom.
No. 110..	36	464	500	37	537	143	680	20	700
" 111..	18	350	368	47	415	92	507	55	562
" 112..	27	313	340	35	375	80	455	35	490
" 113..	18	417	435	50	485	97	582	18	600
" 114..	27	405	432	72	504	72	576	24	600
" 115..	27	308	335	37	372	100	472	25	497
" 116..	27	445	472	38	510	108	618	21	639
" 117..	9	206	215	40	255	94	349	20	369
" 118..	18	517	535	32	567	99	666	25	691
" 119..	18	304	322	18	340	125	465	20	485
" 120..	18	492	510	30	540	102	642	23	665
" 121..	30	143	173	29	202	111	313	27	340
" 122..	36	134	170	40	210	90	300	35	335
" 123..	14	346	360	45	405	110	515	25	540
" 124..	16	294	310	30	340	135	475	25	500
" 125..	30	304	334	38	372	97	469	23	492
" 126..	15	441	456	20	476	124	600	24	624
" 127..	18	410	428	20	448	102	550	24	574
" 128..	18	312	330	56	386	100	486	25	511
" 129..	27	235	262	35	297	102	399	28	427
" 130..	20	286	306	41	347	100	447	28	475
" 131..	18	507	525	40	565	100	665	24	689
" 132..	16	217	233	30	263	110	373	24	397
" 133..	26	169	195	45	240	105	345	20	365
" 134..	13	470	483	39	522	98	620	35	655
" 135..	28	469	497	30	527	102	629	29	658
" 136..	13	417	430	71	501	72	573	23	596
" 137..	11	349	360	40	400	100	500	26	526
" 138..	14	366	380	45	425	95	520	22	542
" 139..	36	306	342	39	381	99	480	28	508

(*Continued from page* 375.)

the old filled up valley of the Tunauquaut, at Tarport, McKean Co. Pa. from 200′ to 300′ of this casing is required in each well.

Wells are spoken of indiscriminately as "small holes" or "wet holes" on the one hand, and as "cased holes" or "dry holes" on the other. A "small hole" must necessarily be a "wet" one, for there is no room to case off the water while drilling; and a "cased hole" must necessarily be a "dry" one, if the casing accomplishes the purpose for which it is used.

If now a well is to be drilled "wet," that is if no effort is to be made to shut off the water which comes into it from the second division mentioned above, to keep it from following the drill down to the oil rocks, then

Digitized by Google

Rock Interval.	Stray Sand. Top.		Stray Sand. Bottom.	Rock Interval.	Third Sand. Top.		Third Sand. Bottom.	Pocket.	Feet Depth.
50	750	30	780	20	800	35	835	2	837
18	580	33	613	19	632	52	684	5	689
53	543	29	572	10	582	43	625	3	628
55	655	32	687	18	705	35	740	3	743
62	662	30	692	18	710	48	758	2	760
60	557	29	586	19	605	52	657	7	664
91	730	31	761	*	750	41	791	2	793
64	483	33	466	18	484	52	536	5	541
62	753	33	786	17	803	45	848	5	853
53	538	30	568	12	580	55	635	5	640
66	731	27	758	20	778	47	825	5	830
61	401	33	434	22	456	45	501	2	503
58	393	31	424	18	442	43	485	2	487
61	601	29	630	20	650	45	695	5	700
85	585	26	611	14	625	38	663	0	663
72	564	22	586	20	606	47	653	2	655
44	668	29	697	18	715	53	768	3	771
53	627	31	658	20	678	54	732	2	734
47	558	27	585	18	603	37	640	5	645
73	500	26	526	12	538	45	583	5	588
77	552	24	576	14	590	40	630	2	632
63	752	28	780	20	800	41	841	3	844
61	458	32	490	17	507	35	542	30	572
64	429	33	462	17	479	38	517	20	537
45	700	35	735	25	760	50	810	5	815
62	720	32	752	15	767	40	807	8	815
64	660	28	688	17	705	45	750	10	760
80	606	26	632	*	630	55	685	5	690
81	623	30	653	*	650	52	702	5	707
43	551	29	580	34	614	44	658	5	663

this "conductor" of which we have been speaking, whether of wood, cast-iron or casing, needs only to be 6″ in diameter, inside measurement. But if the well is to be drilled "dry," an 8″ conductor must be used, as will be seen further on.

In the first case (for a wet well), after the conductor is in place, a plain 5½″ hole is drilled all the way to the oil rocks ; the water, meantime, nearly filling the well, or perhaps overflowing at the top of the conductor.

In the latter case (for a dry hole), an 8″ hole is to be drilled from the bottom of the conductor to a point below the water veins. When this is

* These are evidently errors in Nos. 116, 137 and 138 as the bottom of the Stray S. S. as here given overlaps upon the 3d S. S.

Digitized by Google

done, a 5⅝″ casing (inside diameter) is inserted, with a device on the bottom so arranged that it will form a water tight joint between the casing and wall of the well. A 5½′ hole is then continued down to the oil rocks from the inside of this last "string of casing." If the casing has been inserted to the proper depth and no water is encountered below it, the sand-pump will soon exhaust the water in the process of drilling, and the well be perfectly dry. But if lower veins of water are struck, the casing must be drawn, the hole reamed out to a greater depth, and the casing continued down below them. After the water is exhausted, a few pails full are poured in as circumstances demand; to moisten the drillings and furnish fluid for the sand-pump.

Comparing now the two wells when completed and ready for the pump, we find them both to be of the same size, 5½″ in diameter. One has simply a conductor through the upper division, all the stratified rocks being bare, is full of water, and has probably shown but very little indication of oil. The other has a conductor through the upper division, casing inside of this to the bottom of the middle division, and is dry—or at least was dry until the striking of the oil sand, when it immediately filled up several hundred feet with oil, or perhaps flowed.

The "dry" well is ready at once for the introduction of the pump tube; the "wet" one must be cased before it is tubed. The casing used for this purpose ("small casing,") is of 3¼″ inside diameter. A "water packer" or "seed bag" is attached to its lower end, which effectually closes the annular space between the outside of the casing and wall of the well. This "small casing," of course, must extend down to the bottom of the second division, the same as the large casing does in the "dry" well, for it has precisely the same duty to perform, the shutting off of the water in the upper rocks from the well shaft.

The well is now tubed with the ordinary 2″ "tubing," having a "working barrel" or pump chamber at the bottom, which is placed at or near the point where the oil enters.

Inside of the "tubing" are inserted the "sucker rods" which are connected in the derrick to the "walking beam," and operate the pump valves below.

Upon starting the pump, the "water packer" prevents any of the fluid outside of the casing from entering the well, and the water inside of the casing and in the uncased portion of the well is soon pumped out and the well is said to be "exhausted." As the well exhausts, the oil, which has been held back in the rock by the pressure of the heavy column of water above it, gradually forces its way into the well and is raised by the pump to the surface, unless it has a sufficient force of gas to flow of its own accord afterwards.

Digitized by Google

AS
36
.A531
Copy 2

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD AT PHILADELPHIA, FOR PROMOTING USEFUL KNOWLEDGE.

VOL. XVI. JANUARY TO MAY, 1877. No. 99.

TABLE OF CONTENTS.

[*Continued on 4th page of cover.*]

Digitized by Google

Digitized by Google

Stated Meeting, January 5th, 1877.

Present 15 Members.

Vice-President, Mr. FRALEY, in the Chair.

Letters of acknowledgment were received from the Academy at Lisbon, Aug. 24 (XV 2; 94, 95), and the Meteorological Office, London, December 1, 1876 (97).

Letters of envoy were received from the Italian Society of Sciences at (Modena) Rome, and the Society at Liverpool, November 25th, 1876.

Donations for the Library were received from the R. S. New S. Wales; the Academies at St. Petersburg, Berlin and Philadelphia; the Societies at Königsburg and Boston; the Institute of Lombardy; Soc. Ital. d. Sci. at Rome; R. Geol. Committee at Rome; S. Capellini; Nouv. Mét. and Rev. Pol. Paris; Astron. and Antiq. SS and London Nature; Franklin Institute; Coll. of Pharmacy; Smith. Institution, Dr. Hayden, and the Brazilian Government.

No. 96 of the Proceedings just published was laid on the table for examination.

The death of Dr. Jos. Carson, at Philadelphia, Dec. 30, 1876, in the 69th year of his age, was announced by Mr. Fraley; and on motion Dr. John B. Biddle was appointed to prepare an obituary notice of the deceased.

Mr. Chase made a communication "On the influence of central forces in determining chemical volumes."

Mr. Britton exhibited specimens of artificial fuel manufactured from the peat bogs near Syracuse, in New York, and remarked upon its resemblance to the lignite of S. W. Arkansas, promising a further description.

Mr. Briggs communicated a paper "On Refraction Tables," by Prof. A. K. Mansfield, of Cordova, S. A.

Dr. LeConte communicated notes and a table to point out the most important features of the memoir published in No. 96 of the Proceedings.

Digitized by Google

Mr. Lesley read characteristic portions of a paper by Mr. Leo Lesquereaux of Columbus, introductory to "The Flora of the Carboniferous of North America," which he is preparing as one of the Reports of Progress of the Second Geological Survey of Pennsylvania.

The report of the judges and clerks of the annual election was read, announcing the following list of officers for the ensuing year:

President.

George B. Wood.

Vice-Presidents.

Frederick Fraley, Eli K. Price, E. Otis Kendall.

Secretaries.

John L. LeConte, Pliny E. Chase, George F. Barker, J. Peter Lesley.

Curators.

Hector Tyndale, Charles M. Cresson, Daniel G. Brinton.

Treasurer.

J. Sergeant Price.

Councillors.

Isaac Hays, Robert E. Rogers, Henry C. Carey, Robert Bridges.

Mr. Lesley was nominated Librarian.

Pending nominations 809 to 829 were read.

On motion the Librarian was authorized to transmit to the Deputy Secretary of the Commonwealth at Harrisburg, for publication in the new volume of Archives, the MSS. Journal of Col. Burd at Fort Augusta, in 1763, taking the needful guarantees for the safety and return of the MSS. to the Library of the Society.

And the meeting was adjourned.

Digitized by Google

Stated Meeting, January 19th, 1877.

Present, 19 members.

Vice-President, Mr. Price, in the Chair.

A letter of envoy was received from the Imp. Botanical Gardens of St. Petersburg, Aug. 15, 1876.

Donations for the Library were received from the Mining Bureau at Melbourne; R. Acad. at Turin; S.Vin. Fiorentino of Naples; the Ulm Art Union; R. Acad. at Brussels; Rev. Pol. and Nature; Cobden Club; Canadian J. of Science, Toronto; Essex Institute; S. N. H. Boston; S. C. E. Boston; Hon. W. W. Crapo, of New Bedford; Sill. Journal; Amer. Chemist; Med. News; A. J. Med. Sciences; Penn Monthly; Franklin Institute; Geol. Survey of Pa; E. D. Cope; Ordnance Department U. S. A., and Corps of Engineers.

No. 98 of the Proceedings just published was laid on the table for the inspection of the members.

The Secretary presented a communication entitled: On the first systematic collection and discussion of the Venango Co. oil wells of Western Pennsylvania, by E. S. Nettleton, C. E., prepared for publication and communicated by J. F. Carll, Asst. Geol. Sur. Pa. in charge of the Survey of the Oil Regions.

Gen. Kane read a description of his recent explorations in Coahuila, Mexico, exhibiting photographs of Mexican soldiers, and describing the movement of the Indian population southward still going on.

Dr. König described his success in establishing a scale of colorimetry for minerals containing titanic acid, &c. and explained his processes.

Mr. Blodget brought to the notice of the Society the text of a proposed Act of Congress ordering a new Arctic expe-

Digitized by Google

dition, the discussion of which was postponed to the next meeting: viz—

And be it further enacted, That the President of the United States be authorized to organize and send out one or more expeditions toward the North Pole, and to establish a temporary colony, for purposes of exploration, at some point north of the eighty-first degree of north latitude on or near the shore of Lady Franklin Bay; to detail such officers or other persons of the public service to take part in the same as may be necessary, and to use any public vessel that may be suitable for the purpose; the scientific operations of the expedition to be prosecuted in accordance with the advice of the National Academy of Science, and that the sum of fifty thousand dollars, or such part thereof as may be necessary, be hereby appropriated out of any moneys in the Treasury not otherwise appropriated, to be expended under the direction of the President. *Provided,* That no part of the sum so appropriated shall be carried to the surplus fund or covered into the Treasury until the purpose of the appropriation shall have been completed, but may be applied to expenses of said expedition incurred during any subsequent year that said expedition may be engaged in its duties.

On motion, Mr. Lesley was elected Librarian for the ensuing year.

The following nominations were made and on motion adopted:

Standing Committees for 1877:

Finance.

Mr. Frederick Fraley,
Mr. E. K. Price,
Mr. Benjamin V. Marsh.

Publication.

Dr. John L. LeConte,
Dr. Daniel M. Brinton,
Mr. W. M. Tilghman,
Dr. Harrison Allen,
Dr. C. M. Cresson.

Hall.

Gen. Hector Tyndale,
Mr. Edward Hopper,
Mr. S. W. Roberts.

Digitized by Google

Library.

Mr. Eli K. Price,
Rev. Charles T. Krauth,
Dr. George H. Horn,
Dr. Kinderdine,
Prof. Houston.

The reading of the list of surviving members was postponed.

The election of new members was postponed to the next meeting.

And the meeting was adjourned.

Stated Meeting, February 2nd, 1877.

Present, 24 members.

Vice-President, Mr. E. K. PRICE, in the Chair.

The photograph of Mr. Daniel B. Smith was received for insertion in the album.

A letter accepting his appointment to prepare an obituary notice of the late Dr. Jos. Carson, was received from Dr. John B. Biddle, dated Jan. 24, 1877.

Letters of acknowledgment were received from the Royal Society at Upsal (93, 94, 95; XV ii). Royal Bavarian Academy, November 19, 1876 (XII i, ii, iii; 93, 94, 95). Prof. L. Rütimeyer, Basil, November 6, 1876 (95); Literary and Philosophical Society, Liverpool, January 5, 77 (97), and the University Library at Strasburg (92—95).

Letters of envoy were received from the Royal Society, New South Wales, Sydney, July 12, 1876; Royal Statistical Society, Upsal; Royal Academy, Stockholm; Royal Bava-

Digitized by Google

rian Academy, Munich; Literary and Philosophical Society, Manchester; and Mr. Linn, Deputy Secretary of the Commonwealth, Harrisburg, returning to the safe keeping of the Library the borrowed MSS. Journal of Colonel Burd.

Donations for the Library were received from the Royal Society, New South Wales; Royal Statistical Society, Upsal; Observatory and Bureau of Statistics, at Stockholm; Royal Society of Antiq., Copenhagen; R. Pruss. A. Berlin; Ger. Geological Society, Berlin; Anthropological Society and Geological Institute, Vienna; Royal Bavarian Academy, Munich; Societies at Ulm and Giessen; Royal Belgian Academy, Brussels: Revue Politique; Astronomical Society, Victoria Institute, and Editors of Nature, London; Literary and Philosophical Society, Manchester; Philosophical and Literary Society, Leeds; Royal Cornwall Pol. Society, Falmouth; Massachusetts Historical Society; D. S. A. Green, Groton, Mass.; Silliman's Journal; Franklin Institute; Zoological Society; Pharmaceutical Association, Philadelphia; Mr. C. A. Ashburner; Librarian of Congress; U. S. Department of State; and the Wisconsin State Historical Society.

The death of Prof. Richard Somers Smith, at the U. S. Academy at Annapolis, Tuesday, January 23, 1877, aged 68, was announced by the Secretary.

The death of Mr. F. B. Meek, at Washington, December 21, 1876, aged 59, was announced by the Secretary.

Prof. Cope displayed and described some Dinosaurian remains (skull, dental bones, &c.) obtained in his last exploration of fresh water strata, in the far West, overlying the marine Cretaceous.

Prof. Cope also communicated a paper entitled "A continuation of researches among the Batrachia of the Coal Measures of Ohio."

Mr. Chase communicated a note on the "Modes of central force which best represent some of the most general forms of chemical activity."

Mr. Blodget read a copy of a bill offered for the conside-

Digitized by Google

ration of Congress, and now before the House of Representatives, authorizing the President to organize a new Arctic Expedition. Mr. Blodget called attention to the arguments in favor of such an expedition, as at present planned, set forth in a pamphlet of forty pages entitled: "Polar Colonization and Exploration, by Henry W. Howgate." As there was a great deal of postponed business for the meeting of the evening, any further discussion of the subject was, on motion of Dr. LeConte, postponed. Mr. Blodget's resolution was as follows:

Resolved, That the proposed expedition for Polar research, to be organized by the President of the United States, and to be placed under the scientific auspices of the National Academy of Science, is approved by this Society, under the assurance that it will be conducted without material risk to life. Under such conditions it may be productive of valuable results in physical science.

On motion, the reading of the list of members was postponed to the next meeting, and the list of pending nominations for membership, from No. 809 to 831, was read and the claims of each nominee in turn presented by the subscribers to the nomination.

Mr. Blodget Britton offered the following resolution, which was, on motion, seconded, debated and adopted, viz.:

Resolved, That the Officers of the Society be authorized to certify the approval of a bill to relieve charitable devises and beques's from collateral tax; and that this Society unites in the prayer for the passage of such a law.

The following is a copy of the text of the proposed law:

An act to relieve charitable devises and bequests from payment of collateral tax.

WHEREAS, When charitable devises and bequests are made for objects of public good it is unwise to diminish that good by taxation: Therefore

Section 1. Be it enacted by the Senate and House of Representatives of the Commonwealth of Pennsylvania, and it is hereby enacted by authority of the same, That all collateral taxes upon legacies and devises for charitable purposes are hereby repealed; and all such taxes not already paid into the State Treasury are hereby relinquished and released.

Mr. Briggs and Mr. Lesley opposed the passage of the

Digitized by Google

resolution on two grounds: 1. That it is not the business of this Society to advise the Government in uncalled-for cases; and 2, That the action of a collateral tax law on charities, so far from being a hardship and a reminiscence of barbarism, is on the contrary beneficial and proper for stimulating men to the right use of their wealth during their lifetime, and for protecting society in the New World against the growth of those mortmain evils which especially characterize the semi-barbarous times and governments of the past.

The contrary view was taken and supported by Mr. Blodget, Mr. Eli K. Price, and Mr. J. Sergeant Price. After which the resolution was adopted, and the officers accordingly empowered to act.

Mr. Blodget desired the Secretaries to see that a record was made of his disclaimer of any such statements and opinions respecting the character and condition of the foundations of the Masonic Temple and Public Buildings as are ascribed to him by some mistake, in the published Proceedings of the Society, No. 97, page 181. Respecting the first-named building he had not, and never had had any knowledge; and respecting the foundations of the Public Buildings he had always known and asserted their excellence.

On scrutiny of the ballot boxes by the presiding officer the following persons were delared duly elected members of this Society:

809. Prof. F. Reuleaux of Berlin, Chief Commissioner of the German Empire at the Centennial Exhibition.

810. Prof. Rudolf von Wagner of Würtzburg, Judge at the Centennial Exhibition of 1876.

811. Prof. Mariano Barcena, of Mexico.

812. Prof. E. H. Von Baumhauer, of Harlem, President of the Centennial Commission of the Netherlands.

813. Prof. George Stuart, Professor of Languages in the High School, Philadelphia.

814. Mr. W. V. McKean, of Philadelphia.

815. Rev. Charles W. Shields, D. D., Prof. of the Harmony of Science and Revealed Religion, Princeton, N. J.

Digitized by Google

816. Mr. Franklin B. Gowan, President of the Reading Railroad, Philadelphia.

817. Mr. Henry Phillips, Jr., of Philadelphia.

818. Mr. Henry Turner Eddy, C.E., Dean of the Faculty and Professor of Mathematics and Civil Engineering in the University of Cincinnati.

819. Mr. Cyrus F. Brackett, M. D., Professor Physics in Princeton College, N. J.

820. Prof. James Morgan Hart, of the University of Cincinnati.

821. Mr. Henry Armitt Brown, of Philadelphia.

822. Dr. Charles W. Siemens, of London.

823. Hon. M. Russell Thayer, Judge, Philadelphia.

824. Hon. Craig Biddle, Judge, Philadelphia.

825. T. Hewson Bache, M. D., of Philadelphia.

826. John H. McQuillen, M. D., of Philadelphia.

827. Geo. Strawbridge, M. D., of Philadelphia.

828. William Goodell, M. D., University of Pa.

829. Mr. Thos. Frederick Crane, Ph. D., Professor of Spanish and Italian in Cornell University.

And the meeting was adjourned.

Stated Meeting February 16th, 1877.

Present, 14 members.

Vice-President, Mr. E. K. Price, in the Chair.

Rev. Dr. Shields, Dr. Goodell, and Dr. McQuillen, newly-elected members, were introduced to the presiding officer and took their seats.

A photograph of Professor Frederick Prime, Jr., was received for insertion in the album.

Letters accepting membership were received from Mr. Henry Armitt Brown, dated Philadelphia, Feb. 6, 1877;

Digitized by Google

from Mr. Craig Biddle, dated 2033 Pine Street, Feb. 6, 1877; from Dr. Geo. Strawbridge, dated 1616 Chestnut Street. Feb. 7, 1877; from Mr. Henry Phillips, Jr., dated 304 S. Eleventh Street, Feb. 11, 1877; from Mr. M. Russell Thayer, dated Chestnut Hill, Feb. 8, 1877; from Prof. T. F. Crane, dated Cornell University, Ithaca, Feb. 8, 1877; from Dr. Charles W. Shields, dated Princeton College, Feb. 8, 1877; from Mr. George Stuart, dated 1528 N. Eighteenth Street, Feb. 12, 1877; from Dr. Thomas Goodell, dated Preston Retreat, Twentieth and Hamilton, Feb. 13, 1877; from Mr. W. V. McKean, dated [Ledger Office], Feb. 16, 1877; from Dr. J. H. McQuillen, dated 2100 Arch Street, Feb. 12, 1877.

Letters of acknowledgment were received from the University of Toronto (96, 98); and the Boston Public Library (96).

Donations for the Library were received from the Society at Lille; Revue Politique; London Nature; Essex Institute; American Chemist; Mr. A. R. Grote, Buffalo; Franklin Institute; Penn Monthly; American Journal of Pharmacy; Medical News and Library; House of Refuge; and Reading Railroad; Mr. Leo Lesquereux; War Department, U. S.; the Commissioner of Education, Washington; Mr. Sam. Scudder; Dr. Robert Peter; and the Mercantile L. Association, San Francisco, California.

The death of Dr. Anderson was announced by the Secretary, on authority of information received from Columbia College.

The death of Dr. Elisha J. Lewis, February 10th, 1877, at Philadelphia, aged   years, was announced by Mr. J. S. Price.

The Secretary read a communication from Mr. Alex. E. Outerbridge, Jr., entitled "On the wonderful divisibility of metallic gold," giving a short description of an experiment made in the Assay office of the U. S. Mint, at Philadelphia.

Mr. Outerbridge electrotyped a film of gold upon a copper-plate the difference of weight before and after the process, in two trials, showing the weight of gold deposited to be 1-10 of a grain, over a surface of two

Digitized by Google

hundred square inches; which, if the gold were equally distributed in a continuous film over the whole surface, would give it a thickness of 1-980,400th part of an inch. A single grain of gold may be beaten out so as to cover seventy-five square inches with a thinness of 1-367,650th part of an inch.

The Secretary read a communication entitled "A measured section of the Palæozoic Rocks of Central Pennsylvania from the top of the Alleghany River Coal Series (on Broad Top) down to the Trenton Limestone, in the Lower or Cambro-Silurian System." by Charles A. Ashburner, Assistant on the Second Geological Survey of Pennsylvania.

Gen. Kane resumed the reading of his communication made at a recent meeting of the Society, describing his personal observations in Mexico, and discussing the ethnological movements taking place in that part of the American Continent.

Professor Cope exhibited and described some fossil remains of a Dinosaur, found by Dr. Newberry in 1870, in one of the cañons of the mountains of Utah, the first ever discovered in Triassic rocks in that part of the Continent. He compared them with others found by himself in 1874.

Professor Cope exhibited drawings of scratched figures on coal shales said to have been formed in an Indian mound near Davenport, Iowa, and now preserved in the Museum of the Davenport Academy of Sciences. One of these drawings represents a kind of zodiac, and the other numerous forms of animals, some of which are easily recognized, while those of others are unknown. These drawings are of such unusual excellence of design, and the accompanying symbols and letters have so Indogermanic an aspect, that doubts were expressed by some of the members present concerning their genuineness.

Pending nominations 830 and 831, and new nominations 832, 833 and 834 were read.

The resolution of the Finance Committee postponed at the last meeting was taken up, and on motion an appropriation

Digitized by Google

of $1500 (fifteen hundred dollars) was made for continuing the printing of the Catalogue of the Library.

Gen. Kane read the following joint resolution offered to Congress.

Resolved, That the President be authorized to confer with the authorities of Mexico for the establishment of a joint commission having for its object the scientific exploration of the border States of Mexico and the United States; the operations of the commission to be conducted under the advice of the National Academy of Sciences. *Provided however,* that nothing herein contained shall be construed as to involve the United States for the payment of any claim which may grow out of such action or proceeding. Act, July 12, 1870.

On motion of Gen. Kane, it was resolved that this Society approves of the passage by Congress of the above Resolution; heartily commending the scientific exploration proposed, and the form of organization suggested.

And the meeting was adjourned.

Stated Meeting, March 2nd, 1877.

Present, 15 members.

Vice-President, Mr. Price, in the Chair.

Dr. Bache, a newly elected member, was presented to the presiding officer, and took his seat.

Letters accepting membership were received from Prof. C. F. Brackett, dated Princeton, Feb. 17, 1877; and Prof. Henry Turner Eddy, C. E., dated University of Cincinnati, Feb. 26, 1877.

A photograph for the album was received from Dr. Geo. W. Anderson, of the American Baptist Publication Society, 1420 Chestnut Street, Philadelphia.

A letter requesting a set of Proceedings for working pur-

Digitized by Google

poses was received from Prof. J. J. Stevenson, dated 314 West 30th Street, N. Y., Feb. 15, 1877; and on motion the request was granted.

A letter requesting No. 73, 75 and 80 of the Proceedings of the Society, and the loan of any cuts relating to the subject of Indian sculptures in the possession of the Society, to be used by him in his work on Indian Antiquities, was received from Mr. E. A. Barber, West Chester, Pa., with references to Prof. T. C. Porter, of Easton. On motion the Librarian was directed to correspond with Prof. Porter, and authorized to grant Mr. Barber's request.

Letters of acknowledgment were received from the Radcliffe Observatory, Feb. 12, 1877; and the Franklin Institute.

A letter of envoy was received from C. P. Ob., St. Petersburg.

Donations for the Library were received from J. J. A. Worsaac, of Copenhagen; Annales des Mines; Revue Politique; Geographical Society and Bureau des Longitudes, Paris; Royal Astronomical Society; Victoria Institute and London Nature; Nova Scotia Institute at Halifax; the Editor of the Naturalist's Directory, Salem; the A. Antiq. Society, Worcester; American Chemist; Index; Mr. Potts of Camden, N. J.; Mr. Fred. Graff, Mr. Hermann Haupt, and the Mercantile Library Co., of Philadelphia; Commissioners of Second Geological Survey of Pennsylvania; U. S. Corps of Engineers, and Public Library of Indianapolis.

The death of Rear Admiral Davis at Washington, Feb. 25, 1877, aged   years, was announced by the Secretary.

Professor Sadtler communicated the results of his recent gas analyses; and Mr. Lesley described the importance of the investigation in a geological sense, as the first ever published which took into account the elements of depth hypsometrical, depth geological, order and age of the oil horizons, and geographical distribution of the groups of wells in a north and south direction from Pittsburgh to Buffalo.

Professor Cope exhibited a vertebral column, thirty-three feet long, of an unusually perfect Elasmosaurus, to which he

Digitized by Google

gave the specific name of *Serpentinus*, and described the points in which it differed from *E. platyurus* (Cope), a description of which had been given at a meeting of the Society nine years ago, and was published in its Transactions.

Professor Cope also communicated evidence of the existence of a new species of Mastodon in the United States, and proposed for it the specific name *M. tremontinus.*

Mr. Chase called attention to some experimental results, illustrating his 6th, 7th and 10th fundamental propositions of central force.

Professor Blazius read a paper entitled "The progress in Meteorology, and its tendency during the last twenty-five years; with some supplementary notes to a recent English work bearing that title.

Pending nominations 830, 831, 832, 833 and 834 were read.

And the meeting was adjourned.

Stated Meeting, March 16th, 1877.

Present, 12 members.

Vice-President, Mr. Price, in the Chair.

Mr. McKean a newly elected member was introduced to the presiding officer and took his seat.

Letters accepting membership were received from Prof. J. M. Hart, dated 228 S. Broad Street, Philadelphia, March 2d, 1877; and from Prof. F. Reuleaux, dated Berlin, Feb. 20, 1877.

Letters of acknowledgment were received from E. A. Barber, dated West Chester, Pa., March 12, 1877, (73, 75, 80); the Lenox Library, dated New York, March 14, 1877, (96, 98); and Prof. J. J. Stevenson, dated 314 W. Thirtieth Street, New York, March 7, 1877 (65 to 98).

A letter of envoy was received from Prof. Daniel Kirk-

Digitized by Google

wood, dated Bloomington, Indiana, March 8th, 1877, with a MSS. communication.

Donations for the Library were received from the Royal Society, New South Wales; the Editors of the Flora Batava; the Royal Belgian Academy; the Revue Politique; the M. C. L., Cambridge, Mass.; Silliman's Journal; New Jersey Historical Society; Astor Library; Mr. E. A. Barber, Prof. P. Frazer, Jr., Dr. Hewson Bache; the Medical News; Journal of Pharmacy; Franklin Institute and Penn Monthly; War Department at Washington, and Don J. Ramon de Ybarrola, of Mexico.

A communication was read by the Secretary entitled, "On Eight Meteoric Fireballs, &c., by Daniel Kirkwood, Professor of Mathematics, Indiana University, Bloomington, Indiana."

Prof. Blazius continued the reading of his paper on "The tendency of modern meteorology."

Dr. Wood communicated a paper entitled "On the asserted antagonism of Nicotia and Strychnia, by Francis L. Haynes."

The Secretary communicated a paper entitled, "Notes on the results of a survey of the iron ore beds of the Juniata District of the Second Geological Survey of Pennsylvania by John H. Dewees."

Prof. Cope exhibited and described a cast of the brain cavity of *Coryphodon elephantopus*, of which a complete skeleton exists, and discussed the homologies of the organ, and showed that the genus to which the animal belongs properly constitutes a fourth sub-order of mammalia lower in type than the Marsupialia.

Pending nominations Nos. 830, 831, 832, 833, and 834 were read.

Prof. Chase offered the following preamble and resolutions, which were seconded, discussed and adopted:

Whereas, It is of the greatest importance that the investigation of natural phenomena, such as the origin and migrations of creatures, noxious

Digitized by Google

to agriculture, should be directed by disciplined men of science, of acknowledged ability and trustworthiness, and

Whereas, This Society has been informed that a vacancy may occur in the post of Commissioner of Agriculture in the Department of the Interior, and

Whereas, The name of our fellow member, and distinguished naturalist and entomologist, Dr. John L. LeConte, has been put forward for recommendation to the President for said appointment, therefore

Resolved, That this Society heartily endorse such recommendation.

Prof. Frazer offered the following resolution:

Resolved, That this Society recommend to its members in the presentation of papers containing references to length, weight and capacity, to add to such units as they may deem preferable, the metric units.

Dr. Rogers offered the following amendment:

And also, That those who may use the metrical system shall convert the same into the English.

The resolution and amendment were ordered to be published on the card of notice for the next meeting, and discussion on their merits was postponed.

The meeting was then adjourned.

(*Continued on page* 661.)

Digitized by Google

On the Progress of the North American Carboniferous Flora, in preparation for the Second Geological Survey of Pennsylvania.

By L. Lesquereux.

(*Read before the American Philosophical Society, January 5, 1877.*)

The purpose of this memoir is to give a short account of the progress which has been made, to this day, in the preparation of the North American Coal Flora as one volume of the current Reports of the Second Geological Survey of Pennsylvania.

At first it seemed appropriate to prepare for publication, and in order to preserve the right of priority of names, a catalogue of the species which have to be described in the Flora, and to define the essential points of the classification, especially the generic divisions.

Details of classification, however, cannot be positively fixed before all the materials used in the preparation of the descriptions of the species have been definitely examined. Then the manuscript of the flora will be ready for the printer and a synopsis of it would be useless. Moreover, a mere enumeration of names would offer little of general interest.

It is therefore more advisable to give in advance an *exposé* of the plan which has been followed in the researches deemed necessary for the preparation of the work; of the available sources of information; of the materials, when and where collected for it; of the point arrived at until now, and, therefore, of the more interesting data which have to be exposed in the publication of this Flora.

Those who have ever examined what is generally called specimens of coal plants, know that they generally represent parts of trunks, whose surface is marked by peculiar impressions; or branches without leaves, whose relation is recognized also by the scars upon their bark; or, for the ferns, especially, fragments or pinnæ of fronds with leaflets, or more generally, of detached pinnules, which, though they may be beautiful, do not give, when considered separately, an idea of the general or true character of the vegetable to which they belong. The classification of the living species of the great family of the ferns is derived more especially from the characters of their fructifications. In the coal, though the ferns constitute by far the greatest part of the vegetation, their fructifications are rarely found, and when found, they are mostly attached to branches or pinnæ separated from the sterile fronds, which then, were, as they are now, often very different in aspect and characters from the fruiting ones. Hence it is very difficult to ascertain their correlation; and thus the paleobotanist may place in one genus a sterile branch when he has to describe the fertile pinna of the same fern, in another. Long ribbon leaves, hard fruits of various shape, also are frequently seen in the shale of the coal; but these are most rarely, if ever found attached

Digitized by Google

to stems, and, therefore the relation of many of them to the plants which they represent prevents their reference to original types, and forces, for their description, an artificial classification which the discovery of a single specimen may overthrow. Hence it happens that, in the pursuit of his researches to recognize the specific characters or even the more distant relations of the vegetable fragments, the paleontologist is forced to look for and to compare a large number of specimens before he is able to fix their references. The subdivisions of the leaves or fronds of ferns, the pinnæ and pinnules, have not between the same species that kind of likeness or affinity of shape remarked between the leaves of dicotyledonous plants. The modifications of form are not only extremely numerous, but present such an anomalous diversity, that botanists unacquainted with this section of natural history could often suppose no generic relation between some of the leaflets which represent the same species. One of the most common ferns of the middle coal measures, a *Neuropteris*, for instance, is nearly always found in detached, fine, large, cordate-lanceolate leaflets, which sometimes measure four to five inches in length and two or three inches in diameter. Some small round or broadly oval pinnules are generally found mixed with those large leaves; they are not even half an inch in diameter; and though they have a similar character of nervation, the difference in shape and size is so marked that they were of course described under a different specific name. Lindley and Hutton were the first to suppose, from their coincidence of local distribution, that they might possibly represent parts of the same plant. Since then, and long afterwards, large branches of fronds have been discovered in this country with the two forms of leaves attached to the same pedicel, the large leaves being borne upon a short stalk, with two small leaflets attached to their base. A number of cases of the same kind might be mentioned; but this one is sufficient, and I quote it not merely to show how great are the difficulties encountered by the botanist in the study of coal plants and what persistence it demands, but to prove that the discoveries made in the coal flora of this continent render now to European paleontologists the same amount of assistance that we have received from their works in former times.

The remains of coal plants, generally pleasant to the eye by their graceful shape, and some of them of very peculiar forms, widely apart from those which are generally observable in the vegetation of our time, could not but, as wonderful productions of nature, excite the interest of the first investigators of the carboniferous measures of Pennsylvania. Already in 1818, Steinhauer had published in the Transactions of the American Philosophical Society his *Fossil reliquia*, where remains of plants now referable to *Calamites*, *Lepidodendron*, *Ulodendron*, *Artisia*, *Sigillaria*, and *Stigmaria*, are figured and described under the collective name of *Phytolithes*. He does not represent any kind of fern; but he mentions in the introduction that most of the specimens of fossil plants from the carboniferous are *Filices* (ferns). After him, in 1820, Granger mentions without descriptions a few specimens of coal plants from Zanesville, Ohio. From that time

Digitized by Google

to 1828, Granger, Cist and Professor Silliman sent a number of specimens to Brongniart, who was then engaged in the publication of his great work upon the flora of the coal. In 1831, Professor Eaton described with figures a fossil scale tree, (*Lepidodendron*), sent to him from Montrose, in Bradford County, Pennsylvania.* In 1833, the same author remarks that Professor James Hall had made in Pennsylvania the most extensive collection of vegetable fossils that had hitherto been made on this continent, and gives the names of six species which had been determined by the aid of Brongniart's figures and descriptions, adding that he had before him twenty-five ascertained species from the coal measures of Pennsylvania. Already in 1831 the description of *Fucoides Brongniarti* was published by Harlan, who had discovered it and mentioned it before as *F. Alleghaniensis*. This species was later redescribed by Hall in Pal. of New York, as *F. Harlani*, and later still Göppert, in his Flora of the Transition measures, rendered a just tribute of homage both to Harlan and to Hall in describing it anew as *Harlania Hallii*. I find in the same historical record of Professor Lesley, mention of a splendid collection of coal plants made at great expense and presented to the Geological Society of Pennsylvania by Dr. Martin. This collection, it seems, has been lost. Then, of a plate of fossil plants of the New Red of Virginia, by Mr. F. G. Clemson; farther on, a paper by Harlan on coal plants, four species of which are figured; and later still, some remarks from the same naturalist upon a species of *Equisetum* referrable to *Asterophyllites* or *Annularia*. To this I may add the record of a memoir published in 1837 by Dr. Hildreth, in Silliman's Journal, where this able geologist and noble man has figured a number of coal plants, mostly undescribed and without names, some of them of indefinite relationships; and of another memoir published in 1847 by Dr. Teschmacher of Boston, who mentions twenty-three species of coal plants from Massachusetts and Rhode Island, some of them figured, and more or less distinctly referrable to species known from the works of European authors. For, at that time, the coal flora of Europe had been already studied with great activity, and besides the works of the older authors, Schlottheim, Artis, Lindley and Hutton, Sternberg, which have lost nothing of their scientific value even to our time, the paleobotanists of America had for points of comparison of their fossil plants the Flora of Brongniart, and his numerous memoirs on coal plants published from 1821 to 1844; a pamphlet of Berger on the fruits of the coal; Corda's Beiträge, a splendid work on the internal structure of fossil trunks and stems; Germar's work on the fossils of the carboniferous of Wettin; Göppert's Systema, 1836; and later, his genera (Gattungen), published from 1841–48; Gutbier; Unger on the *Calamites*; and less important memoirs of authors, Binney, Geinitz, Schimper, Roemer, etc., who have now become far-famed by notable works on the vegetable paleontology of the coal.

From this rapid synopsis it may be seen how little was known of the carboniferous flora of North America when, in 1851, I was called to join the

* I quote this and the following data from Professor J. P. Lesley's historical sketches, as I have had no access to the mentioned memoirs.

Digitized by Google

corps of the first Geological Survey of Pennsylvania as Paleobotanist, and was then requested, not merely to collect and study the coal plants, and to give an account of them, but to find in regard to their stratigraphical distribution some data which might be of application for the determination of the relative position of the coal beds. I went to work then; but when I look now upon those first researches of mine, I can but feel a deep sense of commiseration for that student of American paleobotany who had never before seen an American specimen of fossil plants, and who was called to prepare a full record of a flora which after twenty-five years of incessant work is as yet, and will ever be, incomplete; and to decide upon problems as far from solution now, after the multiplied researches of a score of naturalists of the highest standing, as they were thirty years ago. And this commiseration does not apply merely to the results of the work, but to the labor itself. I had as yet never had any collection of coal plants of my own, and thus had no points of comparison whatever. I had merely studied these plants in some of the more important cabinets of Europe, especially that of Strasbourg, which had furnished to Brongniart a large part of the materials used for his Flora. And, except a copy of Sternberg lent to me by the director of the survey, I had no books. The work had to be done, however. Spending days, even whole weeks, upon the great heaps of black shale, now such a marked feature of the landscape of the Anthracite fields; cutting and turning over those shales, sometimes heated by the sun to such a degree that they could hardly be taken into the hands; comparing incomplete fragments in trying to recognize the original characters of the plants; carefully collecting all that seemed of any value to my purpose, and heaping and transporting lots of specimens on my back, however great the distances might be, I had soon materials enough at my command. For then most of the mines were new openings; the shales were generally taken out, and lay uncovered, and some of the coal beds were very rich in fossil remains. Moreover, I found already some fine cabinets of fossil plants open to me for examination; that of Mr. Clarkson of Wilkesbarre; of Mr. Jones of Carbondale, both very intelligent gentlemen, superintendents of coal mines; and many fine specimens, isolated as curiosities by hotel keepers or land proprietors, were presented to the survey. All these specimens after being examined and labeled by a No. of order corresponding with those of my book of references, in which remarks on the specification were written, were boxed and sent to the address of Professor Rogers at Philadelphia; except, however, those which had to be figured for the plates of the report, or which as yet, of uncertain relation, had to be more carefully studied.

At the suggestion of the director of the survey I had prepared for publication in the Boston Journal of Natural History (August, 1854) an abridged description of the new species of fossil plants found in the coal fields of Pennsylvania. But the final report was mostly made at the house of Prof. Rogers at Boston, where all the specimens of the survey were then, and where I spent three months in a final review to close the memoir

Digitized by Google

on the fossil flora of the coal. When I delivered it, it was with the understanding that I should have the privilege of reviewing the manuscript before it was delivered to the printer, or at least of correcting the galley-proofs. But I heard nothing more about it, nor a word from Prof. Rogers; and thus I supposed that the publication of the report had been abandoned; when I received, in 1858, a printed copy of the plates, with a note requesting me to correct them if I found it advisable, and stating that the report was already definitely printed. Of course, as I had no copy of the manuscript, nor any proof prints, I could not correct the plates, which are moreover satisfactorily engraved. It is not necessary to say that if I could have reviewed the memoir before its publication it would have been, if not re-written entirely, at least greatly modified; for after some years of further researches for specimens of coal plants in the Pennsylvania anthracite fields, I should have had some important corrections to make and a number of interesting data as additions to it. For indeed its phraseology is very poor, the descriptions incomplete, and some of the species incorrectly named; the orthography of the Latin names especially is abominable; but as it is the same for the nomenclature of Prof. Rogers, the printer is accountable for the defect. Even on the subject of incorrect determinations of species little has been criticised of the memoir by European authors, and the continued examination of a great number of specimens up to this time has confirmed them with few exceptions. *Asterophyllites ovalis* and *crassicaulis* are fruiting branches now referred by some botanists to *Annularia*, by others to *Sphenophyllum*, by myself still to *Asterophyllites*. The characters of these remains are now known by specimens as complete as may be obtained of petrified vegetable organisms; their relation is, however, not determined upon, and is still in discussion among European authors. *Alethopteris obscura*, of which a mere fragment, seemingly far too incomplete for satisfactory determination, is represented Pl. I, was later discovered at the same locality, in whole pinnæ, which show the same characters and relation as marked in the first description. *Cyclopteris* (*Neuropteris*) *fimbriata* has not only been found at different places, especially in Illinois, always representing the characters originally ascribed to it, but even Prof. Heer, who, when the species was first published, considered it as an imaginary or abnormal representation of leaves of ferns, has it now from the anthracite measures of Switzerland, and has described two species remarkably similar to or perhaps identical with it. The splendid *Neuropteris Rogersii* has been found again in many specimens, at the same and only locality where it had been originally discovered, preserving its identity of characters. Another specimen also has been obtained of the queerly branching *Sphenopteris Newberryi*, with the same peculiar forking of its pinnæ. And the *Lepidodendron* species, though multiplied too far according to Schimper, have been studied from an immense number of specimens from the lower plant bearing strata of the whole extent of the North American coal measures, and their specific characters have been found persistent upon large trunks and upon small branches, therefore with

Digitized by Google

the scars of very different size. Some corrections have to be made, as said above, but certainly not more than would be demanded for a work of this kind, pursued under the most unfavorable circumstances, twenty years after its publication.

After the close of the survey or of the exploration under the direction of Prof. H. D. Rogers, I had continued, on my own account and at my own expense, the explorations for the study of the coal plants of the anthracite fields of Pennsylvania. In the fall of 1857, while stopping at Pottsville for the examination and determination of a large lot of specimens of fossil plants in the cabinet of the Pottsville Scientific Association, I was requested by some members of the society to prepare a catalogue of all the species which had come under my examination in Pennsylvania and other States, including the species which I had then recognized in the Pottsville cabinet. This catalogue, delivered February 1858, was immediately published. It comprises the names of 286 species, including those copied from a list of the species of coal plants from Ohio by Dr. Newberry. Most of the species described in my report to Prof. Rogers are named, and form the largest part of it; some however being left out as uncertain, others added and described and figured as new. No reference is made in this catalogue to the Pennsylvania Geological Report for the good reason that I did not know if this report should ever appear in print. But as the new species described in it had been already published, and their names were thus public property, and as the others were those of species described by European authors, I was then and am now still unable to see how the publication of this catalogue could be considered as a breach of literary obligation, according to the expressions of the Pennsylvania report, p. 878. It is certainly needless to say any more on the subject.

I had at that time become acquainted with the fossil flora of the Pennsylvania coal measures quite as sufficiently as I thought needful for my purpose, and I was anxious to pursue the exploration in other coal fields in order to be able to study the characters of the vegetation of the coal at distant localities, for the elucidation of more important questions, those especially referable to the geographical and stratigraphical distribution of the species at the carboniferous period. For it would not do to attempt to expose a history of the American coal flora merely from data obtained in Pennsylvania. With this idea I began a new series of field explorations, and the examination of all the collections of fossil plants to which I could gain access; and this work has been pursued nearly uninterruptedly until now. First I went, twice, along the Ohio river from Pomeroy down to Gallipolis, and up the Kenawha river to the salines of Charlestown, Virginia. I had then the opportunity to see the cabinet of Dr. Hildreth at Marietta, and to begin with this justly venerated geologist a series of relations and mutual communications continued to his death. At Charlestown I had access to a fine cabinet of specimens of the Rev. Mr. Brown, who had a number of interesting and new species. I collected myself good material for study in the mines worked then above that place. I visited the more interesting

Digitized by Google

portions of the coal measures of Ohio; twice the mines of Cuyahoga Falls; those along the railroad from Cleveland to the mouth of Yellow creek; the coal strata under the Flint ridge near Newark; those of Zanesville. and down the Muskingum river, thus passing over the coal fields in various directions.

I had been before to Nashville to see Professor Troost and his celebrated cabinet of mineral specimens, which had then scarcely anything referable to vegetable paleontology. I found later, however, at Lebanon, in the collections of Prof. Jas. M. Safford, State Geologist of Tennessee, a fine lot of remarkably well preserved impressions of ferns, with some hard fruits, *Carpolithes*, *Trigonocarpes*, some of them new species.

These private researches becoming too expensive for my very limited means, and also too little productive in results of importance to my researches, I readily accepted the proposition of Dr. D. D. Owen, to join his corps of assistants on the Geological State Survey of Kentucky, and gave to the work two or three months each year. These explorations were of little account, and did not afford any valuable discoveries in vegetable paleontology. For except the coal beds of the upper stage, worked for the use of steamboa's along the Ohio river, and which had no fossil remains of plants, most of those exposed inland were then unopened for want of communications, and thus I had rarely any opportunity to get good specimens.

The results of the geological *reconnaisance* in Arkansas, under the same direction, were far more valuable and interesting. But here, again, it was impossible to stop at peculiar places for prolonged investigation for fossils. So hurried were the explorations made, with the necessary incumbrance of a camp, that for the examination of the finest exposition of a coal, that of Malés, where there was an abundance of specimens, we had scarcely one hour of time. This exposure was at the top of a mountain where no water and no feed could be got for the horses, and arriving at the mines late in the evening when it was already nearly dark, we had to leave at daybreak, and thus was lost the only good opportunity I had to compare the characters of the sub-carboniferous flora of that State with those of the true carboniferous of the Eastern basins.

The specimens hastily secured in that short time, however, proved very valuable; for if they did not represent a number of species sufficient for a determination of the general character of the vegetation, they showed mostly new types, as may be seen in the second volume of the Arkansas Geological Report, where they have been described and figured in five plates.

My next explorations in connection with the Geological State Survey of Illinois were, per contra, very productive in valuable discoveries in relation to the flora of the coal. The very able chief of the survey, A. H. Worthen, then gave not only to the direction of the work the greatest energy, looking for every possible opportunity of examining himself the coal strata whose station was still uncertain; but whenever we had chances of obtaining fossil remains he gave me sufficient time and his own assistance for

Digitized by Google

collections which, transferred to the large State cabinet of Springfield, were afterwards examined and determined at leisure. Some localities, like that of Morris, Grundy county, for example, where the vegetable fragments are preserved both in soft shale, and in very hard concretions, afforded a rare opportunity for the study of a local distribution of the coal flora and also of a remarkable exposition of its richness and luxuriance. For the concretions there hold in preservation some of the small and soft vegetable remains which are generally destroyed by a protracted maceration in porous materials like shale or sandstone. There were moreover at Morris some private cabinets of gentlemen interested in fossil botany by the beauty of the specimens obtainable in the vicinity, those of Jos. Even, S. S. Strong, Prendel, Armstrong. These were kindly opened for my examination, and afforded abundant materials for study. The essential results of the paleobotanical explorations in Illinois are exposed in the second and fourth volumes of the Geological Reports of that State, and their importance may be judged by the table of species, Vol. IV, p. 471, whose number amounts to two hundred and twenty-six, a number which has been greatly increased since then. Some of the species recognized in the flora of Morris are extremely interesting, remarkable indeed for characters which had nowhere been recognized until then in the vegetation of coal, and which therefore might be supposed to be somewhat imaginary or derived from obscure specimens. These, however, like *Neuropteris Verbenæfolia*, *N. pachyderma* of the second volume, have been re-discovered in better specimens, though the first were already satisfactorily determined. And this was the more opportune that the first and only specimens used for exemplification and belonging to Mr. Even had been lost by a fire which destroyed his whole property. This second volume also figures some peculiar species to which is attached a double importance and significance, by their own characters, and by their relations to types generally considered as strangers to the carboniferous formations. Of these I will say something more after finishing the enumeration of the means employed for increasing the amount of materials serviceable for the study of the coal flora.

While occupied with the surveys, I had always, in pursuance of the same plan, looked for every opportunity of examining local collections or encouraging local researches for specimens of fossil plants. The specimens of Amherst College had been entrusted to me for determination. I had seen also those of Yale College, those of Prof. J. D. Dana; determined the species in the cabinet of Princeton College, and established correspondence for exchanges or communications; among others with Mr. T. H. Clark, of Newport, R. I., who had for a long time collected specimens of plants from the coal of Mount Hope, which by and by gave a very interesting contribution to the North American coal flora. More recently a new light was thrown into the obscure question of the vertical distribution of the coal flora and upon the characters of its groups, by the communication of a whole cabinet of fossil plants from the coal fields of Alabama, sent for determination by the Director of that Geological Survey, Prof. Eug. A. Smith.

Digitized by Google

A mere catalogue of the names has been published in the first volume of his first report, together with a reference to the group or geological division indicated by these plants. The remarks then made on this subject have been confirmed by subsequent communications of specimens from the same coal fields; those of Mr. T. H. Aldrich, proprietor of the Montevallo coal, and of Mr. Thos. Sharp, Superintendent of the Newcastle Company.

Since my connection with the Second Geological Survey of Pennsylvania explorations of the same kind have been pursued with renewed activity, and these have been still more fruitful and more interesting than those of old. They have greatly increased and multiplied the field of researches, constantly adding new materials to those which were at hand, and thus showing how great is the richness of the vegetation of the coal, and how backwards we are yet in our acquaintance with it. We have now a group of fossil plants from Clinton, Mo which, collected by Dr. Britts in lower carboniferous very productive shale, not only represents many new species, but, taken in the whole, affords a fair point of comparison for the western lower coal measures. Another from the Cannelton Coal of Beaver county, Pa. (Coal C, of Lesley), where M. J. F. Mansfield, the proprietor, has, at great expense of time and money, pursued systematic explorations in the roof shales, which there hold remains of plants in profusion. This local flora will become an important representative of the vegetation of the middle part of the lower carboniferous. Prof. Worthen has sent a lot of plants, some of them of new and remarkable types, from under the Chester Limestone of Western Illinois; and Prof. E. T. Con, another not less interesting from the Whetstone grit of Indiana, which overlies the same sub-carboniferous formation. From the same geologist I have had for determination a number of specimens of fucoids, or remains of marine plants, very remarkable in their typical relations, all discovered in the coal measures of Indiana. Though these do not belong to the Pennsylvania survey, and have been described in the last report of Indiana, they pertain, of course, to the Coal Flora. And more still, we have received from Illinois a lot of specimens from the pseudo-carboniferous, representing plants of the same characters as those discovered by Prof. E. B. Andrews in the Waverly Sandstone of Ohio. This communication is due to Mr. S. H. Southwell, of Fort Byron, Ill. who discovered also at about the same horizon specimens of one of the species of fucoids described in the Indiana report.

Last fall I visited twice the sub-carboniferous coal beds around Sharon and Youngstown, to ascertain the character of their vegetation, and obtained valuable specimens, some of them of new species. I made also a short tour of exploration in the basins of the Swatara river and Raush creek to compare once more the plants of the Mammoth with those of the Salem vein. Besides the specimens found by myself, a number of others were then presented to the Survey by Mr. T. Price Wetherill, of Tremont. Mr. W. Lorenz, Superintendent of the Philadelphia & Reading

Digitized by Google

R. R. directed the researches to the more interesting localities, presented to me all the specimens found by himself, and when I returned to Philadelphia gave me the privilege of examining his cabinet, to select from it all the materials which might be of use to my work.

The last, but not the least, important communication to the Survey is due to Mr. S. S. Strong, of Morris, Ill. I have already remarked upon his cabinet, which was opened for my researches in connection with the Geological Survey of Illinois. Since that time this proficient explorer of vegetable remains has constantly increased his splendid collection, especially from the nodules of Mazon creek. Lately he proposed that I should go to Morris to make a fair review of his specimens and to determine them, offering to the Survey, as a compensation to my work, all those which I should consider as representatives of very rare or new species. This examination has added an important store of materials of great value to those which we had already; and it is evident that by the addition of a number of species of various types, either new or not observed before at Morris, we have in the flora of that locality the best possible point of comparison for geological distribution of the coal flora; while, by its station between the two essential subdivisions of the coal measures. it offers the same advantages for judging of the modifications of the plants in passing from the sub-carboniferous upwards.

To close this enumeration of the resources now in store for the preparation of the North America Coal Flora I have still to mention the publications made in this country upon the same subject; for of course this Flora has to take into consideration the materials used in the preparation of these works. The most important ones are the memoirs of Professor J. W. Dawson, of Montreal, who has studied for years the Devonian and lower carboniferous floras of Canada, and of the Western States with a patience and industry which have justly rendered his name famous. After this in degree of importance we have, in the first volume on the Paleontology of the Geological Reports of Ohio, a valuable monography of fruits of the carboniferous by Dr. Newberry. It throws much light upon the true characters of those vegetable remains so rarely found in a good state of preservation, and so difficult to study, especially in regard to their relationships. A number of them had been briefly described, by the same author, in the Annals of Science, 1853. The second volume of the same Report is enriched by a memoir of Professsr E B. Andrews, upon species of fossil plants discovered by himself in the formation of the Waverly Sandstone of Ohio. By the precise descriptions and the splendid illustrations of the species representing new typical forms of the vegetation of the coal this memoir is indeed an important contribution to vegetable paleontology. We had had before upon some species of the *Vespertine* of Virginia a too short paper from Professor B. F. Meek, with two fine plates of illustrations, and an accuracy of description which so remarkably characterized this paleontologist who leaves behind him a wide-world repute. This has been followed up by another memoir on the conglomerate series of Virginia, by Pro-

Digitized by Google

fessor V. Fontaine. No plates are given as illustration of the species; but these are so carefully described that the characters are easily recognized without figures. In connection with Professor I. C. White, these gentlemen are now studying a lot of fossil plants whose discovery is due to Professor John J. Stevenson, but whose specimens were collected by themselves. They represent an upper section of the carboniferous, apparently touching on the Permian. The results of this study which they intend to publish soon, can not fail to add new materials which ought to contribute to the fullness of the coal flora.

From all that has been seen above it is clear that this *Coal Flora,* in preparation for the second Geological Survey of Pennsylvania, is not merely a description with figures of the species of the coal measures of that State. The concentration of such researches within precise geographical limits would deprive them of any importance, and of any scientific value; for the work done in that way would give only a very meagre representation of the vegetation of the coal period, and it is desirable to know it in its whole extent, as far as our acquaintance with it has advanced until now. I purpose, therefore, to consider all the plants found in the coal measures, from the eastern limits of the continent (New Scotia, New Brunswick) to the eastern borders of the coal fields in Kansas. Even farther West, in the Rocky Mountains, a few remains of *Calamites* have been found. They represent merely two species recognized in the Permian as well as in the carboniferous of Europe, and they offer no great interest by their specific characters. They have to be described, however, as serviceable for comparison in case of future discoveries. And considering the vertical distribution of the vegetation of the coal, it is advisable also to give to this flora the widest possible range, and to admit into it all the species of land plants recognized on this continent, from the first appearance of land vegetation in the upper silurian strata, to the end of the carboniferous period. The true devonian species, those which have not yet been observed in the Catskill or Old Red sandstone, now considered as lower carboniferous, are very few in number, not more than half a dozen perhaps. It is probable that similar or related types may be recognized hereafter in the true coal measures. We want to know them, therefore, for eventual comparison. Moreover, they enter into the history of the coal flora as ancestors; and in its records nothing should be omitted which may throw any light into the important question of the development of the primitive types, reappearing under modified characters. I quote a single example as illustration. There is in the coal of Morris a species of *Neuropteris,* with leaflets seemingly branching in an anomalous way, by the splitting of the rachis either at the base or in the middle of the leaflets. This species, described as *Neuropteris fasciculata,* has been considered as a kind of monstrosity or a casual decomposition of the leaflets, as we see sometimes in the living flora. But the same character is seen already in *Megalopteris,* a species of the lowest coal measures; thus we find it continued in that *Neuropteris* of Morris, and thereby have a proof of its persistence from the base to the middle of the carboniferous.

Digitized by Google

Let me now answer the questions which the above exposition may have suggested. What is the purpose of this work? What are the results already obtained from the researches? What may be expected of its completion? A constantly more intimate acquaintance with the characters of the coal flora is the first and natural result of prolonged and extensive explorations. This will not say, however, that we shall have by this a full history of the vegetation of the coal. For, as it has been remarked in the beginning of this paper, the fossil vegetable remains of the coal are generally mere fragments, which, considered separately, do not show the characters of the whole plants to which they pertain. These can be recognized only by the comparison, sometimes of a large number of specimens; and it may even be said that many of the species of the coal are without any scientific value, for the reason that they are defined by characters which belong to mere fragments. And the deficiency of reliable specific characters apply not only to the coal plants themselves, but become more evident still in the attempts made to fix their relation to the plants of our time.

The insufficiency of the evidence afforded to the student by those mere fragments of vegetables has been complained of by the most sagacious paleontologists, and has discouraged the most ardent followers of Paleobotany. Lindley and Hutton bitterly lament it in their fossil flora of Great Britain, which, however incomplete it may be, has become a classic or leading work, and is now re-edited in its integrity. Hooker, the prince of the botanists of our age, while connected with the Geological Survey of England, makes, in his report, a comparison of the vegetation of the coal with that of our time, and devotes the largest part of it to exemplify by figures and descriptions how rarely fragments of ferns may represent the characters of the species to which they belong. He has, however, in the exposition of the structure of the *Stigmaria* and of *Lepidostrobi*, the fruits of *Lepidodendron*, anatomically studied from silicified specimens, thrown such light on the affinity of those plants, that his too short memoir is considered as the most important on the subject. Brongniart, also a prince among the botanists of his time, spent many years in exploring the coal measures of France and Belgium, in visiting all the museums where specimens of fossil vegetables were preserved, before he began, in 1828, the preparation of his great work on the fossil flora of the coal. Adding to his stock of materials by exchanges and by communications received from the scientific world at large, he pursued his labors until 1844, when he abandoned the work half done. His *Flora* is, however, even now the most reliable guide to the student of Paleobotany. Göppert, too, supposing that from the immense number of specimens of coal plants gathered into his splendid cabinet he should be able to fix a new classification of the ferns of the coal from the characters of their fructifications, began his Genera (*Gattungen*) in 1841, and abandoned it, discouraged, after six fascicules had been published. This work, however, incomplete as it is, has, by the exemplification of the structure of a number of forms of the fructifications

Digitized by Google

of ferns, directed researches toward this new field of exploration and opened a path which, by and by, enlarged by new discoveries, may afford a more reliable way for the determination of species of this family. Still more recently, Goldenberg attempted a detailed monography of the fossil plants of Saarbruck (*Flora Saræpontana*), where he had found an abundance of valuable materials. Of it he published only three fascicules; but they represent a valuable monography of the *Sigillariæ*, and this also is a gain to the fossil flora.

What conclusions may be derived from this? Shall we say that the coal flora cannot be studied with advantage from a number of specimens observed at peculiar localities? Shall we admit that this flora cannot be studied at all, and that it should be left in its grand and sublime mystery? The first assertion is right; the second rests upon an objection, which may be made against every study, which tends to the interpretation of documents whose writing is as yet imperfectly known. The hieroglyphs of the Pyramids are still more obscure, still farther from exposing a comprehensive record of the history of the people who built them. Some have been deciphered, nevertheless, and a few pages of the writing have thrown a deal of light upon that history and have been accepted by science as a momentous revelation. The history of our earth is not a less important knowledge than that of the races of men who have inhabited it. And how can it be studied in all its bearings, if we do not take into consideration the physical laws which have governed its atmosphere from the beginning? The plants are the true recorders of atmospheric circumstances, and the fossil plants the documents, the hieroglyphs written and left in the strata of the earth for the interpretation of their laws. They have recorded them as clearly as it is done by the instruments used now, the thermometers, the barometers, the hygrometers, etc. Shall we not open the great book and try to read at least some of its pages, though they may have become obscured by the walk of time? And as all animal life depends on plants, the concordance of the development of both the vegetable and animal worlds, should not be forgotten when we come to consider the advantages which may be derived from the study of the coal flora of America. For, of course, these advantages cannot be derivable in such plenitude from an acquaintance with the vegetation of a single country. What has been discovered in Europe, from paleontological evidence, has to be either confirmed, or perhaps, presented under a new light, by what may be found on this continent.

The results of the researches on the remains of coal plants in this country, as far as they have now reached, may be already accounted creditable and valuable. They have proved the existence of land vegetation, as far down as the Upper Silurian period. They have settled the question of the existence of a marine vegetation in the true coal measures, where fucoidal remains, some of them referable to old types, have been discovered in Pennsylvania and Indiana. They have also positively established the fact of the existence of *Fungi* or Mushrooms at the epoch of the coal. But by far the more in-

Digitized by Google

teresting data procured refer to the discovery in our carboniferous measures of species of plants which have been until now considered in Europe as characteristic of more recent formations. Thus we have in the sub-carboniferous, under the Chester limestone of Illinois, leaves referable to the genus *Glossopteris*, as described by Brongniart, and remarkably similar to those of his *G. Nillsoniana*. This genus, says Schimper, has no analogous in the present vegetation, and its existence appears limited to the first half of the Jurassic period. This is remarkable indeed; and it might be supposed that though the specimens of this species are very clearly defined in their characters, they may represent a different and new type with a mere casual likeness. But we have at Morris, from the first coal above the millstone grit, a fine leaf of *Phlebopteris* (*Dictyophyllum*), preserved in its integrity, with its distinct characters, the peculiar nervation not remarked in any other genus. And this genus is also Liassic, for Europe at least. Beside this, the coal of Morris is related to the Permian of Europe by a number of identical types, a fact remarked already by Schimper. The species of *Spirangium*, for example, are not rare in the nodules of Mazon creek. From the sub-carboniferous of Alabama and of Pennsylvania we have two species of *Tæniopteris*, a genus also considered in Europe as limited to the Permian. This enumeration might be pursued farther; but the peculiarities of distribution will be better understood when accompanied by the description of species, and by the notes upon their relationships.

From the remarks made already it is easily understood that the documents concerning the geographical distribution of the species of the coal flora have been carefully searched for and recorded. They are already valuable for comparing the characters of the vegetation, not only in the different basins in North America, but of Europe also. To elucidate this question as far as possible stations, fixed at distant localities, and where long and persistent explorations have been pursued, are especially valuable. With the station of Newport, Rhode Island; that of Cannelton, Pennsylvania; of Morris, Illinois; of Clinton, Missouri; of Pomeroy, Ohio; of two localities in the coal mines of Alabama, we may expect to find by comparison of the floras reliable documents in regard to the question of the horizontal or geographical distribution of the species.

The last and more important question refers to the stratigraphical distribution of the coal plants; and to it belongs, as a postulate, that of the possibility of determining the relative horizons of the coal beds from the vegetable fossil remains possibly discovered in connection with them. This question has been for a long time, and is still, at issue among European paleontologists, who are generally inclined to admit that there is or should be a marked diversity in the floras of coal strata of different ages or of different horizons. Imbued with this persuasion I began researches in Pennsylvania with the idea that in a fair and open field like that of our carboniferous measures, which are exposed to exploration, sometimes for great thicknesses of strata, and besides, over very wide areas, a problem of this kind should be easily solved. My belief in the applicability of paleontology

Digitized by Google

to the identification of the coal beds was confirmed by the opinion of the miners, who, when questioned on the subject, generally asserted that it was for them an easy matter to tell one coal from another by comparing the roof shales, and their remains of plants. My first attempt to a determination of this kind, in connection with the first Geological Survey of Pennsylvania, was, as observed by Professor Lesley, a marked failure. For I considered the Salem vein of Port Carbon as the equivalent of the Mammoth, while these represent the two extremes of the Anthracite measures, one at the base, the other in the upper part. But paleontology is not accountable for a personal blunder, which, moreover, was forced upon me by peculiar circumstances which, if they do not make it excusable, at least explain it. I had found, back of the hill facing Port Carbon, just after passing the cut of the railroad entering Mill creek, large heaps of shale extremely rich in fossils, and had there made a prolonged search for the study of a well determined local flora, when I was informed by a miner that I should find opposite, and at the foot of Sharp Mountain, the same kind of shale with abundant specimens of the same plants. There, indeed, I found *Pecopteris arborescens*, an essentially characteristic species of the upper coal, with *Neuropteris Loschii*, and other species seen at the first locality; but with them were remains of *Lepidodendron*, of species of *Sigillaria* and of *Alepthopteris*, which I had formerly recognized above St. Clair, in connection with the Mammoth vein. This seemed so extraordinary that I visited the same places many times on the supposition that I had been mistaken by false appearances in the characters of the plants; but the same evidence was always there; and I came to the conclusion that from all appearances, that coal of Port Carbon was the equivalent of the Mammoth, though differently placed by Professor Rogers. For all the coal beds along the valley of Mill creek are turned up vertically, and therefore, their relative position was at that time unascertained. It was only after years, that in my rambles around Pottsville, on revisiting again the heap of shales of Sharp Mountain, I was informed by the Superintendent of a coal mine whom I met in the vicinity, that these debris were from a tunnel pierced through a number of small veins including the upper ones, to reach the bottom vein, the Mammoth, which was found there too thin to be worked and had been abandoned. Therefore the remains of plants of a number of coal beds of different horizons were there mixed together. I do not say this in order to support an opinion which, in regard, at least, to the application of vegetable paleontology to the identification of coal strata, has been, by long experience, if not altered, at least reduced in the main. For I know well, now, how rarely remains of fossil plants are found in the same degree of profusion in connection with coal beds of the same horizon; how rarely, when these remains are found, they represent the same species, or, at least, have them in the same proportional distribution; and how careful and protracted the study of the flora of the same coal has to be before it is possible to know the peculiar species which may belong exclusively to it, or be considered as the leading ones. For this

Digitized by Google

knowledge includes, with the acquaintance of the greatest number of species recognized at a peculiar locality, that of their mode of dispersion over wide areas, or of the changes caused locally by the geographical distribution of the species. When the coal beds are, therefore, at great distances, it is not possible to leave off the idea that the modifications in the characters of the plants, if differences are observed, may have been caused as well by local synchronous influences as by a difference in the time of their formation or in their age. Nevertheless, I still believe that in basins of limited areas or for beds of coal of one and the same locality, the remains of plants in the roof shale may serve to identify the different strata, and may thus be used as a direction by the miners. But even in such cases the paleontological indications may fail or lead to mistakes; for the changes in the constituents of the roof shales are often sudden and remarkably varied. The Cook vein of Western Kentucky, for instance, has in its shale a profusion of remains of *Lepidodendron* and *Lepidostrobi* on one side of the main gangway, while on the other it is transformed into a kind of compact bone or cannel coal with no other fossils but small shells.

When the subject of the vertical distribution of the vegetation of the coal is considered *a priori*, it seems rational to admit that the same vegetable types cannot have been persistent for such a period of time as was necessary not only for the growth and accumulation of the plants which have entered into the composition of a coal bed from six to ten feet thick, or more, but for the heaping of the intercallated strata, sandstone, limestone, shale, etc., which sometimes measure hundreds of feet in thickness. The study of the floras of our time does not afford us any data in regard to the duration of vegetable types. The human races are still too young, or at least the records of the present vegetation do not yet reach far enough to afford evidence of the modification of any species of plants. We have, however, positive facts in the more recent geological times which prove a remarkable degree of persistence in the characters of a flora for a distance of time, as indicated by interstratified formations, still longer than it may be supposed necessary for the production of two coal beds, and hundreds of feet of shale, sandstone, etc. between them. In the Tertiary of the Rocky Mountains, strata bearing plants in connection with lignites have been found at Point of Rocks, Wyoming Territory, and a number of identical species, indeed, a flora bearing the same general characters, is exposed, also with lignite beds, at Black Butte, though the two localities are separated by three to four thousand feet of measures, shale, sandstone, lignite beds, etc. If these lignite floras had been considered separately and without evidence of the distribution of the intervening measures, they would have been admitted as evidently synchronous, or as representing the same horizon. Hence the long persistence of vegetable types is a fact which has to be recognized by paleontologists although it may be contradictory to theoretical considerations.

The modifications in the characters of the plants are recognized, however, in the flora of the Carboniferous; but they have been slow, tran-

Digitized by Google

sitional, and affecting essentially the general features of periods. They give to separate groups a peculiar character, which may serve to separate them. In a lot of plants sent by Prof. Eug. Smith from Alabama, for example, I found such a dissimilarity of typical forms from those of the coal measures of the north, and also such an affinity with those of the Arkansas sub-carboniferous flora, that this relation forcibly referred both to the same period.

The distinctive characters of the groups of the Carboniferous can be only briefly exposed now; but they are to be more positively fixed in the Flora by separate tables indicating all the species of plants which have been recognized in each of them. This will prove an interesting representation of the distribution of the vegetation of the coal, not merely by the number of species, but especially as a kind of scale marking the progress in the modification either by disappearance of some types, or by their reproduction under different characters.

The groups as recognized until now are the Catskill, or old red; the Pseudo-carboniferous; the Sub-carboniferous, or Vespertine, limited upwards by the millstone grit; the Lower Carboniferous, up to the Pittsburgh coal; and the Upper Carboniferous, above it.

A few species of small Lycopodiaceous plants of the genus *Psilophyton* (Daws), appear first in the upper Silurian, and continue, by modifications of size especially in the Devonian, where four species are recognized. I consider this genus as representing the only Devonian type which does not pass up into the Carboniferous. There may be some others, however, as indicated by fossil wood: *Dadoxylon, Syringoxylon, Prototaxites*, etc. But the anatomy of the fossil wood of the whole Carboniferous is not yet advanced enough to allow conclusions on the characters of the vegetation represented by fossil trunks. Prof. Dawson is still pursuing with an industrious energy his researches on this difficult subject, which, to my regret, has remained inaccessible to me for want of materials. For except the fossil wood of the Black Devonian shale of Ohio, no specimen of silicified vegetable organism has been discovered in coal measures of the United States, except the numerous stems of fern trees of Southern Ohio. These might give materials enough for the work and studious application of a whole life.

The more notable characteristic type of the Catskill group is that of the ferns described first under the generic name of *Næggerathia*, and more recently of *Palæopteris* and *Archæopteris*. The species are represented by large fronds; those of the older type with simple leaflets more or less enlarged upwards from a narrowly cuneate, somewhat decurring base, whose veins are straight and diverging, fan-like, merely by sub-divisions. The forms of the leaflets are very variable; some appear nearly linear and merely thinly lined with parallel veins. These, however, pass to the genus *Cordaites*, which is present in the whole flora of the coal measures. The modifications of *Psilophytum* are possibly represented in the Catskill by a few species of *Lepidodendron*. *Calamites*, *Annularia* and *Asterophyl-*

Digitized by Google

lites have there, also, some rare representatives. In the Pseudo-carboniferous, characterized as it is now by the species published by Prof. Andrews, from the Waverly Sandstone of Ohio, and those determinable from the specimens from Port Byron, Ill., the *Paleopteris* continues to be present. But some of the species have lobed or decomposed leaflets, tending by these characters to a section of the *Sphenopteris*, which comes later. The predominant forms are those of *Megalopteris*, a splendid fern whose advent is not prefigured in the flora of the Catskill by any species known until now. But in its large leaflets and its nervation, it evidently betokens the great family of the *Neuropterideæ* to which belong the most beautiful and varied forms of the coal plants. The same rock group has rare species of *Alethopteris*, also with very large fronds and leaflets, *Hymenophyllites*, and broadly winged fruits of the genus *Cardiocarpon*. One species of *Paleopteris*, similar to *P. obtusa*, is remarked in this division as well as in the Catskill group. And on another side it has some species of *Lepidodendron*, *Lepidophloios*, a small *Asterophyllites*, etc., which continue higher up, and enter the sub-carboniferous measures. We have as yet too little data in regard to the flora of the Catskill, and that of the Pseudo-carboniferous to be able to positively recognize the points of affinities and of difference. Most of the species have been described from Canada and Maine, and their age generally ascribed to the Devonian, or marked under the indefinite appellation of pre-carboniferous. The flora of the sub-carboniferous division is, *per contra*, known by a large number of its species. It is allied to the pseudo-carboniferous by those which are named above; by species of *Sphenopteris*, *Triphyllopteris*, *Eremopteris*, and especially of *Alethopteris*, of analogous types. It has for its own predominant characters some *Neuropteris*, with large fronds and small leaflets as *N. Smithii*, which though extremely abundant in Alabama and Virginia, has not as yet been discovered in the coal measures above the Millstone grit; *Neuropteris tenuifolia*, which persists even to the highest strata of the coal, is there also. Professor Fontaine has seen in the Vespertine of Virginia species of *Odontopteris*, a genus predicted by the fine *Eremopteris marginata* of the pseudo-carboniferous. This one partakes of the *Odontopteris* type, quite as much as of the *Eremopteris* character, recalling also something of the facies of *Megalopteris*, which has not been seen in the sub-carboniferous until now. In this last division, the number of species is, as stated, greatly multiplied, and it becomes now difficult to positively mark those which are limited to it. The *Lepidodendron*, especially, are extremely abundant. The old types *L. Sternbergii*, *L. Veltheimianum*, *L. aculeatum*, etc., appear mixed with more recent ones, and with others which seem peculiar to this division: as *L. squamiferum* from the Helena vein of Alabama, which bears upon its bark true scales, easily detached, and at the same time, the scars of leaves generally remarked upon the trunks and branches of *Lepidodendron*. The collateral genera are represented also: *Ulodendron*, *Halonia*, *Lepidophloios*, *Knorria*; *Stigmaria* is there in abundance, though remains of *Sigillaria* are as yet extremely rare. Among the

Digitized by Google

species which have been considered in Europe as characteristic of the Mountain Limestone of the culm, we have in the sub-carboniferous of Alabama and Virginia *Alethopteris nervosa*, *A. muricata*, and *Sphenopteris Hœninghausii*, this as common in the shale of the Helena coal as *Neuropteris Smithii*. These three species, however, ascend in the American coal measures to above the Millstone grit, which, though a kind of geological delimitation, as well traced here as in Europe, is not a very definite line of demarcation between the vegetable groups. For, with few exceptions, the lower carboniferous flora has still the types of the sub-carboniferous, merely modified, and represented by an increased or diminished number of species. The lycopodiaceous are still more abundant; and we have, especially in the lower veins, immediately above the Millstone grit, the largest number of species of *Lepidodendron* and *Ulodendron*. *Stigmaria* and *Sigillaria* have gained in predominance; and in the ferns, new species of *Neuropteridæ*, especially some large-leaved *Neuropteris* and *Odontopteris*, are seen for the first time. The wide-ranged *Alethopteris Serlii*, and its analogous species *A. lonchitica*, are there also; the first already seen in the sub-carboniferous, the second a derivation of *A. Helenæ*, of the same lower division. *A. Pennsylvanica* and *A. Sullivantii*, may be counted too in the first coal above the conglomerate, as prefiguring in their more important characters those of the *Callipteris*, which comes later in order of time. For one species of this last genus only is known in the lower carboniferous, and another from the Cannelton coal, already somewhat high up in the measures. As the largest number of the species of plants of the coal have been obtained from the lower carboniferous, it would be possible to continue the enumeration of the species which are considered as proper to it or as characteristic. But subsequent researches may greatly reduce the number; for as yet few strata bearing remains of plants have been discovered in the upper carboniferous. This division may be limited from the base or from the top of the barren measures underlying the Pittsburgh coal; for indeed we know as yet nothing of the flora of these barren strata. In ascending from the Millstone grit, after passing the two first coal beds above it, the vegetation is rapidly modified in its characters by the gradual disappearance of the Lycopodiaceous types, and the increasing predominance of the ferns. The species of *Sigillaria* continue in about the same proportion; *Annularia*, *Sphenophyllum*, *Asterophyllites*, become more abundant. And while some of the generic divisions of the ferns, like *Alethopteris* and the large-leaved *Pecopteris*, seem to pass away; the group of the *Cyatheæ*, represented by *Pecopteris arborescens*, *P. oreopteridia*, *P. polymorpha*, etc., become the more numerous, and especially characterize the upper carboniferous. They mostly belong to tree ferns, which, besides the extreme abundance of their pinnæ in the highest veins of Pennsylvania, have left, petrified in the sandstone of Ohio and Virginia a prodigious quantity of trunks representing whole forests. With these there is no trace of *Lepidodendron*; some *Sigillaria* are left. The vegetable world was at that period a world of ferns, mixed with the *Cordaites*, a race of as yet undetermined relation, it seems, half-lycopodia-

Digitized by Google

ceous, half conifers. These plants are mostly known by their long linear, ribbon-like leaves; their stems have been very rarely found. Some large, bushy species of *Neuropteris* have persisted. *N. hirsuta* and *N. Loschii* ascend from the Millstone grit to the Permian. And above the Pittsburgh coal or even in connection with it are found the *Callipteris*: *Callipteris Moorii*, and *Callipteris conferta*, this last species one considered in Europe as Permian, and found by the Virginian geologists, Fontaine and White, in the highest strata of the carboniferous. We have seen, however, that many other so-called Permian types are remarked in the American coal measures already from below the millstone grit; and therefore, it is not as yet advisable to consider as Permian those upper strata which, beside this *Callipteris*, have a number of representations of truly carboniferous species.

It remains only to state how far the work on the American coal flora has progressed towards its completion. The plates, sixty in number, are all ready. The number might be still further increased by several species which cannot be clearly represented by descriptions only; but wood cuts may be used for the purpose, if it is advisable and possible to have any intercallated into the text. The description of the species and the remarks upon their diversified characters, as seen in the comparison of the specimens, have been all written, and, therefore, the manuscript may be definitely prepared in a short time. It is, however, not yet in its final shape, as the records have to be left open for the admission of any valuable data which the continued communications of materials may bring to the Flora.

This synopsis is very incomplete, but it cannot be made comprehensible without the tables of distribution, even if a large number of species were enumerated. Moreover the limitation of the vegetable groups is not yet definite enough. New and indeed very desirable discoveries, especially of plants of the Lower Carboniferous, the Vespertine of Pennsylvania, and the Devonian Hamilton Coal Measures of the Juniata, may compel important modifications. Therefore, the divisions as marked above, as well as their names, should be considered only temporary. They are subject, of course, to geological evidence which ought to govern them. The final nomenclature of the groups of the "Coal Flora" must accord with that of the Second Geological Survey of Pennsylvania.

Digitized by Google

Tabular Synopsis of the Rhynchophora of America.

(See Minutes of January 5, 1877.)

Dr. Le Conte presented a tabular statement of the number of species of Rhynchophora, contained in the XV. volume of the Proceedings of the Society, and their geographical distribution in the different zoological provinces of temperate North America. He mentioned the instances in which the occurrence of similar extraordinary forms in geographical regions very remote from each other corresponded with what he had previously shown in the other higher types of Coleoptera, and again expressed the opinion that the isolated and feebly represented, though sometimes widely distributed forms in insects were representative survivals of the faunæ of former geologic periods ; and proceeded :

It is useless to oppose this view by the statement that these composite, synthetic, prophetic or undifferentiated types have not yet been found in the strata, for every well-informed entomologist will remember that except in Tertiary strata but few localities have presented specimens sufficiently preserved to permit accurate study. Moreover the localities thus far explored are all in the temperate zone, where we may reasonably not expect to find the predecessors of the larger and more conspicuous forms.

In the older rocks the insect remains are so compressed, and the sutures of the most important elements of the external skeleton so obliterated, that but little knowledge can be had except from the venation of the broad winged orders. In this respect there is, as I can state from information furnished me by Dr. Hagen, a striking correspondence between some of the Carboniferous lace-winged insects and our own existent *Pteronarcys.*

But in fact. *Pteronarcys*, being peculiar, among all genera of similar form and appearance, by possessing in the adult distinct remnants of the larval branchiæ on the anterior segments of the abdomen, would necessarily, by my method of interpreting structures, be regarded as a survival of an ancient form, even if no *Miamia* wing had been found in the coal quarries.

A better appreciation of the characters of resemblance, which ally the more important groups represented at present in the various classes of animals, as contrasted with the differences between them and their analogues of former periods, the remains of which are found in the rocks, and which are occasionally represented by survivals of insignificant size or restricted area, will enable entomologists to take broader views of the capabilities of the branch of science which they cultivate ; but in which too often their attention is directed to squabbles about nomenclature, orthographic or historical, and to the simple enlargement of our knowledge by the description of generic and specific forms.

Digitized by Google

Tabular Synopsis and Geographical Distribution of Families, Subfamilies, north of Mexico, by J. L. Le Conte, assisted by George H. Horn, and XV, No. 96. (See Minutes of January 5, 1877.)

NAME. Family. Subfamily. Tribe.	NUMBER. Genera. Descr.	New.	Total.	Species. Descr.	New.	Total.
I. RHINOMACERIDÆ	1		1		4	4
II. RHYNCHITIDÆ						
i. Rhynchitidæ	3		3	10	11	21
ii. Pterocolidæ	1		1	1		1
III. ATTELABIDÆ	1		1	4	1	5
IV. BYRSOPIDÆ	1		1	1?		1?
V. OTIORHYNCHIDÆ						
1. Brachyderini	4	5	9	6	5	11
2. Ophryastini	6	12	18	13	13	26
3. Otiorhynchini	7	11	18	19	23	42
4. Dirotognathini		1	1		1	1
5. Tanymecini	4		4	4	3	7
6. Cyphini	5	3	8	5	8	13
7. Evotini	2	1	3	1	2	3
8. Phyllobiini	2	2	4	2	3	5
9. Promecopini	3		3	4	1	5
VI. CURCULIONIDÆ						
i. Sitonidæ	1		1	8		8
ii. Alophidæ	1	5	6	7	4	11
iii. Ithyceridæ	1		1	1		1
iv. Curculionidæ						
1. Phytonomini	4		4	24	19	43
2. Emphyastini	1		1	1		1
3. Hylobiini	5	2	7	13	2	15
4. Cleonini	3	3	6	16	25	41
5. Erirhinini	13	6	19	22	48	70
6. Trachodini	1		1	3		3
7. Otidocephalini	1		1	7	1	8
8. Magdalini	1		1	12	4	16
9. Anthonomini	2	3	5	17	34	51
10. Prionomerini	2		2	2	1	3

Digitized by Google

Tribes, Genera, and Species, mentioned in the Rhynchophora of America, published in the Proceedings of the American Philosophical Society, Vol.

DISTRIBUTION.						COMMON TO OTHER CONTINENT.	
GENERA.			SPECIES.				
Atlantic.	Central.	Pacific.	Atlantic.	Central.	Pacific.	Genera.	Species.
1		1	2		3	1	0
3	2	2	12	5	6	3*	0
1			1				
1	1		4	2		1	0
1	-1		1?	1?			
3	3	4	4	4	4	1	1
7	2	12	11	2	14		
3	12	6	4	25	14	3	5
		1			1		
3	2		6	2		1	0
5	4		6	9			
1	2	1	1	2	1		
4		1	4		1	2	1
3	1		3	2			
1	1	1	3	1	4	1	5
1	2	6	1	3	8		
1			1				
4	4	4	33	5	6	2	3
		1			1	*	
6		2	13		3	3	0
3	6	3	14	19	13	3	0
17	9	11	47	16	20	8	4
		1			3	1	0
1	1	1	6	1	1		
1		1	8	2	7	1	0
4	4	4	39	6	12	2	
2			3				

Digitized by Google

NAME. Family. Subfamily. Tribe.	NUMBER. Genera. Descr.	New.	Total.	Species. Descr.	New.	Total.
11. Tychiini........	2	6	8	1	15	16
12. Cionini.........	4		4	3	1	4
13. Derelomini......		1	1		3	3
14. Læmosaccini...	1		1	1		1
15. Cryptorhynchini	8	8	16	34	45	79
16. Zygopini........	2	1	3	4	9	13
17. Tachygonini....	1		1	2	2	4
18. Ceutorhynchini..	6	3	9	15	24	39
19. Barini..........	2	15	17	40	44	84
20. Hormopini......		1	1		1	1
v. Balaninidæ..........	1		1	6		6
VII. Brenthidæ..............						
i. Brenthidæ..........						
1. Arrhenodini....	1		1	1		1
2. Brenthini.......	1		1	2		2
ii. Cyladidæ...........	1		1	1		1
VIII. Calandridæ............						
i. Calandridæ..........						
1. Rhynchophorini	1		1	2		2
2. Sphenophorini..	3	3	6	33	4	37
3. Calandrini......	1		1	3		3
ii. Rhinidæ............		1	1	1		1
iii. Cossonidæ..........						
1. Dryophthorini ..	3	1	4	2	2	4
2. Cossonini.......	5	2	7	13	1	14
3. Rhyncolini......	7		7	11		11
IX. Scolytidæ..............						
i. Platypodidæ........	1		1	5		5
ii. Scolytidæ...........						
1. Tomicini.	10	1	11	56	13	69
2. Scolytini........	1		1	6	3	9
3. Hylurgini.......	11	3	14	35	7	42
X. Anthribidæ.......... .						
1. Tropiderini.	3	5	8	3	7	10
2. Basitropini.....	5	3	8	10	8	18
3. Aræocerini......	2		2	1	2	3
4. Xenorchestini ..	1	1	2	1	1	2
XI. Apionidæ...............	1		1	22		22
	161	109	270	517	405	922

Digitized by Google

Distribution.						Common to Other Continent.	
Genera.			Species.				
Atlantic.	Central.	Pacific.	Atlantic.	Central.	Pacific.	Genera.	Species.
5	1	3	10	1	5	2	0
4			4			4	3
1			3				
1			1				
13	5	5	65	11	8	3	0
3	1	2	9	3	5		
1	1		3	1		*	
9	3	3	31	5	9	7	4
14	9	6	71	20	10	?	
1			1				
1	1	1	6	1	1	1	0
1	1		1	1			
		1			2		
1			1			1	0
1		1	1		1	1	0
2	4	4	21	25	13	1	0
1	1	1	3	1	1	1	2
		1			1		
4	1		4	1		1	0
6	1	2	13	1	3	4	0
5	1	3	6	1	6	5	0
1		1	4		1	1	0
10	3	7	47	7	27	6	0
1	1	1	4	1	5	1	0
12	4	9	25	6	21	7	0
6	1	3	7	1	3	1	0
8	1		17	1		2	0
2		1	3		1	1	1
2			2			1*	0
1	1	1	13		9	1	0
163	98	118	591	194	255		

Digitized by Google

Remarks:

I. This family consists of but one genus; one species is found in Europe; all others known occur in our fauna.

II, i. Rhynchites is cosmopolitan; Auletes occurs in Europe, and Eugnamptus in Asia. The latter is the most feebly developed of the family, and resembles in its distribution, Othnius and Ischalia of the Heteromera, and tribe Tachygonini (VI. iv, 17, mentioned below.

II, ii. Pterocolus is an isolated form, having at present no relationships with other genera, though a feeble resemblance in form to the Ceutorhynchini (VI, iv, 18). If my method of interpretation be correct, there were older genera, by which Pterocolus and Tachygonus were affiliated.

III. Attelabus is cosmopolitan, and seems to be the highest development in the series Haplogastra.

IV. The Byrsopidæ are represented in all zoölogical regions, except Australia; but our genus, Thecesternus, represents an isolated group. From the great differences between individuals, which seem to have unstable specific characters, I am disposed to regard this group as an ancient survival, in the process of evoluting into something else. The variations in the length of the humeral processes of the elytra, and in the sculpture are scarcely explicable, unless we suppose that species formerly distinct are hybridizing. That an ancient type should suddenly effloresce in modern times to produce many species is hardly conceivable, and we should, therefore, be willing to admit, that in this instance the phenomenon is one of absorption, or integration rather than differentiation.

V, 1. *Barynotus Schönherri* occurs in Northern Europe, and is subarctic, and therefore quite capable of being found on both continents.

V, 3. Two species of Otiorhynchus are arctic, and common to both continents; three have been introduced with fruit trees. Mylacus occurs in Europe and Asia, and on our Pacific Coast; Trachyphlœus in Europe, Asia, and in Eastern America.

V, 5. Tanymecus is supposed to be cosmopolitan, but has not yet been properly studied. Of the other genera in our fauna, Pandeleteius and Pachnæus extend to the Northern Tropics of America, and Hadromerus even to Brazil.

V, 6. Cyphus is largely represented in Tropical America, and is conjectured to occur in Asia (*C. chrysis*, Fabr). The other genera, so far as known, are North American, or extend only into the Northern Tropics.

V, 7. The only described genus of this tribe is Lachnopus, which extends from the Northern Tropics into our fauna. The other genera in our fauna are new, and their distribution is not yet known.

V, 8. One species of Phyllobius has been introduced from Europe into Canada. Scythropus occurs on both sides of the continent, in Europe, and also in Northern Africa.

V, 9. This tribe seems to be exclusively American, and one genus, *Coleocerus*, extends to the Southern Temperate Zone.

VI, i. Sitones is confined to the northern hemisphere; of the eight species in our fauna, five occur in Europe, and of these, but one, *S. tibialis*, can be supposed to have been introduced.

Digitized by Google

VI, ii. This sub-family is confined to the temperate and subarctic regions of the northern hemisphere; the genera are all different from those recognized on the other continent, though it is quite possible that some of them may be represented in Northern Asia.

VI, iii. Ithycerus is an entirely isolated form, having no relations to other genera, so far as known to me.

VI, iv, 1. One species of Phytonomus and two of Lepyrus are common to the subarctic regions of both continents. Listronotus and Macrops probably extend into tropical America, but a renewed study of the old genus Listroderes must be made before this can be definitely stated.

VI, iv, 2. This peculiar maritime fossorial tribe is represented by a different genus in Australia.

VI, iv, 3. Plinthus, Hylobius, and Pissodes, are confined to the northern hemisphere, but may be represented (*teste* Schönherr) in Brazil and Australia. Hilipus is largely represented in South America, but not on the other continent, unless *H. orientalis* Motsch, from Japan, should on proper examination prove to belong to the genus.

VI, iv, 4. The genera in this tribe are very indefinite, and the foreign species still require revision to bring out the facts in geographical distribution. Lixus, Cleonus, and Stephanocleonus, are the only examples I can mention at present of genera common to both continents.

VI, iv, 5. *Procas picipes*, two species of Grypidius and *Tanysphyrus lemnæ*, are common to the northern part of both continents, and have not been introduced. The only genus which extends to Tropical America is Phyllotrox.

VI, iv, 6. Trachodes is subarctic, and occurs on both continents.

VI, iv, 7. Otidocephalus is peculiar to North and South America.

VI, iv, 8. Magdalis is cosmopolitan, but most largely represented in Europe and North America.

VI, iv, 9 Anthonomus is cosmopolitan, or nearly so. Orchestes is confined to the northern hemisphere. The other genera in our fauna are new, and their distribution is consequently unknown.

VI, iv, 10. This tribe seems to be exclusively American, but both genera extend into the southern tropics.

VI, iv, 11. The tribe Tychiini has not been separated from Erirhinini sufficiently accurately to make any observations of value at present.

VI, iv, 12. I do not know if the species common to Europe and America have been introduced or not. The tribe, by the diminished number of joints in the funicle of the antennæ indicates a low grade, and the genera are widely diffused on the eastern continent, but do not occur in South America or Australia.

VI, iv, 13. This small tribe is represented on both continents; the species have not been studied with sufficient care to indicate the distribution of the genera.

VI, iv, 14. This tribe is American, and best represented in the tropics.

VI, iv, 15. With the exception of Acalles, Cryptorhynchus, and Cœlo-

Digitized by Google

sternus, which are supposed to be cosmopolitan, our genera are not found on the other continent. Those which have been previously described, mostly extend to the southern tropics of America, and of the eight new genera, nothing can yet be said. As a tribe the distribution is general.

VI, iv, 16. Copturus abounds in tropical America, and is feebly represented in tropical Asia. Piazurus is entirely American. As a tribe the distribution is general.

VI, iv, 17. Tachygonus is exclusively American ; one species is Brazilian. The only representative in foreign parts is *Dinorhopala* Pascoe, in Burmah.

VI, iv, 18. With closer comparison the number of species common to Europe and the United States may probably be increased. There is but one, *Ceutorhynchus rapæ*, which may have been introduced.

VI, iv, 19. Until a new study has been made of Baris, Centrinus, and allied genera, any remarks upon geographical distribution would be premature.

VI, v. Balaninus, as recorded in the Munich Catalogue is cosmopolitan ; a better study of the foreign species is necessary, in order to know if they possess the essential character of the subfamily ; the vertical movement of the mandibles.

VII, i. Our two genera extend into tropical America.

VII, ii. *Cylas formicarius* has probably been imported from Asia, though *Convolvulus batata*, upon which it depredates, is considered an American plant.

VIII, i, 1. Rhynchophorus is cosmopolitan, but confined to tropical and subtropical regions, being parasitic upon palm trees. Sphenophorus is cosmopolitan. Calandra has deen distributed in cereals until it is now difficult to determine whence the species have emigrated.

VIII, iii, 1. Dryophthorus seems to be cosmopolitan, the other genera are local, so far as known at present.

VIII, iii, 2. Cossonus and Mesites are common to both continents ; Caulophilus is found in Madera, and Himatium in India. Stenomimus occurs in Brazil, and Homaloxenus in San Domingo.

VIII, iii, 3. Stenoscelis is almost cosmopolitan ; Rhyncolus is found throughout the northern hemisphere, and in Brazil ; Phlœophagus, Amaurorhinus, and Hexarthrum in the Atlantic Island and Europe ; the last named also occurs in Japan.

IX, i. Platypus is cosmopolitan.

IX, ii, 1. Pityophthorus, Xyloterus, Xyleborus, Dryocœtes, Cryphalus, and Tomicus, are common to both continents.

IX, ii, 2. Scolytus is widely diffused on both continents.

X, 1. Tropideres is the only genus occurring on the other continent.

X, 2. Anthribus and Brachytarsus are represented in Europe.

X, 3. Choragus also occurs in Europe. Aræocerus is cosmopolitan, and distributed in articles of commerce.

X, 4. Xenorchestes has been found only in Madeira.

XI. Apion is cosmopolitan.

Digitized by Google

On Refraction Tables.

By A. K. Mansfield, Cordova, S. A.

(*Read before the American Philosophical Society, January* 5, 1877.)

The operation of computing the difference between the true and the apparent zenith distances of stars, is usually performed by means of Bessel's refraction tables, which are calculated from his formula, namely:

$$R = d\ tan\zeta\ (BT)^A \gamma^\lambda\ *$$

This operation is usually logarithmic, and the refraction tables are therefore tables of logarithms. The computation may, however, be very much simplified, by the use of natural numbers in place of their logarithms, as will appear from the following:

In the above formula substitute R for $d\ tan\zeta$, and ρ for $(BT)^A\gamma^\lambda$. The formula then becomes

$$R = R_1\rho \text{..}(1)$$

in which R_1 may be called the mean refraction, and ρ is a factor depending almost entirely on the temperature and pressure of the atmosphere. For general purposes two tables may be made, one of mean refractions (R_1), being the natural numbers corresponding to the table "$d\ tan\zeta$" of Bessel. and the other of corrections to the mean refraction. But since these corrections would be sometimes additive and sometimes subtractive, the latter table would be reduced to a smaller compass, if each observatory or place where the tables are adopted were to adapt them to the true mean refraction of that place. This may be done as follows:

Let ρ_0 be that value of ρ, which substituted in equation (1), would give true mean refraction for any particular place: and let R_0 be that mean refraction. Then

$$R_0 = R_1\ \rho_0 \text{..}(2)$$

R_1 is given by its log. in Bessel's first table "*log. d tan*ζ," and a round value for *log* ρ_0, near the above mentioned mean, may be chosen. From this formula a new table of mean refractions in natural numbers can easily be made.

Let r be the correction to be applied to this mean refraction. Then

$$r = R - R_0 = R_1\ (\rho - \rho_0) \text{..........................}(3)$$

from which the table of corrections may be calculated.

*See Peter's "Astronomische Tafeln und Formeln."

Digitized by Google

In making the table, comparatively few values need be computed, for, having these few values, the others may be supplied by interpolation. The following is a small portion of a table of these corrections, in what appears to be its most convenient form. It was computed from Bessel's tables, as given by Peter's.

log. ρ	—0.01000	1100	1200	1300	1400	1500	&c.
ζ	Mean *R.*						
15°	15.12	0.03	0.07	0.10	0.14	0.17	
	106						
16	16.18	0.04	0.08	0.11	0.15	0.19	
	107						
17	17.25	0.04	0.08	0.12	0.16	0.20	
	108						
18	18.33	0.04	0.09	0.13	0.17	0.21	
	110						
19	19.43	0.04	0.09	0.13	0.18	0.22	
	111						
20	20.54	0.05	0.10	0.14	0.19	0.24	
	112						
21	21.66	0.05	0.10	0.15	0.20	0.25	
	114						
22°	22.80	0.05	0.11	0.16	0.21	0.26	
log. ρ	—0.01000	.00900	0801	0702	0604	0505	&c.

Apparent zenith distance is here used as argument at the side. It may be replaced, however, by the corresponding declination, or the circle reading. *Log.* ρ is used as argument at the top, and —0.01000 is the assumed value of *log.* ρ_0. When *log.* $\rho =$ *log.* ρ_0 the correction is zero, therefore we have written the table of mean refractions in that column, thus combining both tables in one. This may be done when the arguments at the side are not chosen so far apart as to make the second differences of the mean refraction too great. In computing the tables from the above formulæ, the *arithmetical complement of log.* ρ must be used, when that *log.* as found from Bessel's tables, is negative. When *log.* ρ occurs in the line at the top of the table, the correction is negative, when in the line at the bottom, it is positive. To find the values of *log.* ρ for the lower line, corresponding to those of the upper line, call the natural number corresponding to any particular value in the upper line ρ_1, and its corresponding value for the lower line ρ_2. Then from formula (3), since r is minus in one case and plus in the other,

$$-\rho_1 + \rho_0 = \rho_2 - \rho_0$$

$$\text{or } \rho_2 = 2\rho_0 - \rho_1 \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Before entering the table of corrections, *log. B*, *log. T*, and *log.* γ are taken as usual from Bessel's tables, are then added, and their sum is the argument *log.* ρ, when the zenith distance is less than 45°. When the zenith distance is 45° or more, a correction on account of the exponent λ is to be ap-

Digitized by Google

plied to the log., and when 77° or more, another correction must be applied on account of the exponent A. These corrections may be found as follows :

Let $log.\ \rho_1 = log.\ (BT) + log.\ \gamma$, then the entire correction

$$r_1 = log.\ \rho - log.\ \rho_1 = log.\ \gamma\ (\lambda - 1) + log.\ (BT)\ (A - 1) \ldots .(5)$$

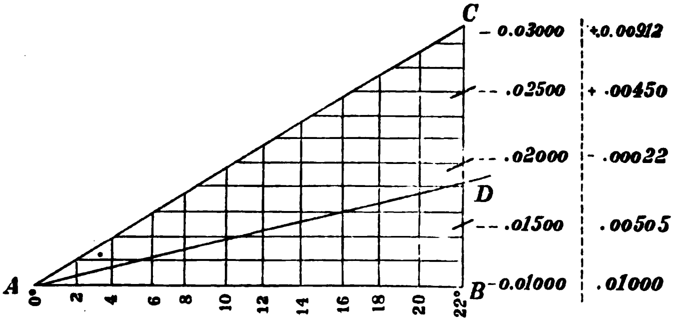
in which the two terms of the last member are the first and second corrections respectively. The following will illustrate a method of tabulating these corrections :

ζ	0.01000	2000	3000	4000	ζ
60°	5	9	14	18	80° 40′
61	5	10	15	20	81 0
62.	5	11	16	22	81 30
63	6	12	17	23	81 50
64	6	13	19	25	82 10
65°	7	14	20	27	82° 30′

The argument at the top is either $log.\ (BT)$ or $log.\ \gamma$, according to which correction is sought for. The side arguments are zenith distances, which may be replaced by declinations, &c.

The first column is used when taking out the first correction, and the last column, when taking out the second correction. To find the values of the argument for the last column, enter Bessel's table "A" with the value of λ for any zenith distance of the first column, and against it will be found the corresponding zenith distance for the last column. The units place of the corrections, corresponds to the fifth place of $log.\ \rho$, and when the logarithmic argument is negative, the correction is negative, and *vice versa.*

In place of the above table of corrections to mean refraction, a graphical table may be constructed, which has some advantages. Let a right-angle triangle $A\ B\ C$ be drawn, containing lines parallel to the base, at equal distances apart.



These equal distances may represent seconds, or tenths of a second. The distance $B\ C$ is made equal to the maximum correction rm, or the correction for the maximum zenith distance, and maximum value of $log.\ \rho$, which

occur in the table. Values of r are now computed for the different values of the argument *log.* ρ, but for the maximum zenith distance, and the results laid off on the line $B\ C$, from the point B; and against the points thus found the arguments *log* ρ are written. Along the line AB are written the zenith distances. Equal increments of zenith distance are represented by unequal increments of the line AB, in order that the line AC, or line of maximum corrections, may be a straight line. Call the co-ordinates of any point of AC. d and r, and the distance AB, dm. Then

$$d : dm = r : rm$$

$$\text{or } d = \frac{dm}{rm} r = \frac{dm}{rm} R_1 (\rho m - \rho_0) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

from which the distances of the arguments from the point A may be determined. The line AD represents the edge of a ruler, or a thread; stretched from a needle at the point A. If this line be turned about A, until it passes through that point BC, corresponding to the value of *log* ρ for which the correction is sought, the correction will be the length of the perpendicular to AB, measured to its intersection with AD, at the point corresponding to the given zenith distance.

This method has the advantage that the interpolations are made separately, and will undoubtedly give good results, if the diagram is drawn carefully, and large enough.

Digitized by Google

On the First Systematic Collection and Discussion of the Venango County Oil Wells of Western Pennsylvania. By E. S. Nettleton, C. E. Prepared for publication and communicated by John F. Carll, Assistant Geologist in charge of the Survey of the Oil Regions.

(*Read before the American Philosophical Society, January* 19, 1877.)

In the fall of 1868 the first systematic attempt was made to ascertain the direction and dip of the Oil Sands of the Venango region and the true relation which the oil producing rock of one district bears to that of another.

This was during the great Pleasantville oil excitement, when, probably for the first time, the attention of a large class of operators was called to the fact that there was a marked difference between the oil and oil sand of Pleasantville and surrounding districts, and the oil and oil sand of Oil Creek.

Previous to that time very few levels had been taken, and those only locally from well to well on the same farm, or within the bounds of one producing centre; but some of the detached districts had been fortuitously connected by lines of levels run for pipe lines from station to station, and by preliminary Railway surveys which crossed the country in almost every direction. From these sources it was ascertained that the Pleasantville oil rock, although called the 4th sand, lay at a higher elevation than the 3d sand of Oil Creek.

Some operators held the opinion that the oil rocks ran horizontally under the whole country, and that by drilling deeper at Pleasantville, the Oil Creek 3d sand would be found, and a much larger supply of oil obtained. Others contended that the rocks dipped towards Oil Creek and the Pleasantville wells had already reached the Oil Creek sand. They went still further, and pointing to the old failures in the Pleasantville district, averred that there was no oil in the rock when these wells were put down, but that the flooding of the oil sands under the valley of Oil Creek, by the abandonment years before of so many wells, had forced the oil from its original home there to these higher portions of the rock.

Discussions on these points showed the necessity for more information on the subject; and while some chose to gain this information on their own account, by sinking wells deeper at considerable expense to see what might be below, a few believed that something could be learned by a careful study of the wells already drilled, in connection with a series of surface levels extending over a large area, embracing in one system all the main oil-producing centres.

As an outgrowth of this idea an informal meeting was held and a committee appointed to plan and carry out the work necessary to be done. Mr. E. S. Nettleton, then residing in Pleasantville, consented to act as one of the committee, and to undertake the task of running the lines of levels and collecting the well records. A circular was issued to well owners, and

Digitized by Google

blanks were prepared for filling in the well records, of which the following are copies:

Circular A. Pleasantville Pa................1868.

Dear Sir:—A pressing need has long been felt by the more thoughtful operators in the Pennsylvania Oil Regions for a more thorough and accurate knowledge of the thickness, dip and general characteristics of the Oil-bearing Rock in this section. The drillings in different localities have established data sufficient for operations in those particular places, but no effort has been made to connect these together in one comprehensive whole, and very little is known as yet of the *relative* positions of the Oil-bearing Rocks in these several localities. In order that this want may be supplied a fund has been raised, a committee appointed to supervise the work, and the services of a competent Engineer secured. It is proposed to make *an accurate topographical survey of Pleasantville, Enterprise, Bean Farm, Pit-hole, Shamburg, Bull Run, and Pioneer Oil Districts*, and then by a comparison of the records of a large number of the most prominent wells in said districts, to prepare and publish a report, which we think will contain facts and figures of great value to those engaged in the development of Oil Territory. In furtherance of this object the enclosed series of questions have been prepared which we hope you will be so kind as to fill out and return to us,—and any further information you may be able to give will be duly acknowledged.

Signed S. Q. Brown, George K. Anderson, J. H. Hebert, John F. Carll, E. S. Nettleton, Committee.

Address all letters to E. S. Nettleton, Civil Engineer, Box 45, Pleasantville, Pa.

Circular B. Pleasantville, Pa.................1868.

Dear Sir:—Please fill out the following blank and mail to E. S. Nettleton, Civil Engineer, Box 45, Pleasantville, Pa.

Record of..Well No......
Located on..Farm.
Lease No...........................Tested.................186..
Distance from surface to top of First or "Mountain" Sand, No. of feet......
Thickness of the First Sand, " ......
Distance from surface to top of Second Sand, " ......
Thickness of Second Sand, " ......
Distance from surface to top of Third Sand, " ......
Thickness of Third Sand, " ......
Distance from surface to top of Fourth Sand, " ......
Thickness of Fourth Sand, " ......
Distance from surface to top of Fifth Sand, " ......
Thickness of Fifth Sand, " ......
Distance from surface to Sixth Sand, " ......
Thickness of Sixth Sand, " ......
What is the entire depth of your well? " ......

Digitized by Google

At what depth were the mud veins?	No. of feet......
At what depth is the seed-bag?	" ......
How far is the bottom of working chamber from the bottom of the well?	" ......
Is your well cased?	......
Quality of the Oil-bearing Rock, Pebble or Sand?	......
What color of oil is produced?	......
Gravity of oil?	......
What has been your best production per day?	..Bbls.
How many engines would the best flow of gas run?	......
What is the Engineer's number of this well as marked on the Samson Post?	......

Remarks:..

During the winter of 1868–9, the work was prosecuted with considerable interest and diligence, but like all other matters not directly personal, it soon began to be neglected by the committeemen who were all deeply engaged in their own affairs, and Mr. Nettleton was left to work out the problem as best he could, almost alone.

Meantime the field widened. New developments at Scrubgrass and Parker's Landing led off to the south, far beyond the limits proposed for our work. Mr. Nettleton had been attracted to the west, and connected himself with the Engineering Corps of Greeley Colony, which made it necessary for him to close up his affairs in the Oil Regions, preparatory to his removal. No one had any personal interest in continuing the investigation, and the work stopt just when it should have been carried forward, leaving the materials in hand in such an unfinished and incomplete condition that no report could be made which would be at all satisfactory to those who had subscribed to the funds for the Survey.

This was in the Spring of 1870. Mr. Nettleton before leaving Pleasantville, placed all the accumulated papers of the Survey in my hands, where they have remained to the present time. They were accompanied by the following brief report to the Committee, dated Pleasantville, April 1, 1870, and addressed to the Committee of the Topographical Survey :

Gentlemen :—I herewith present to you the facts and papers relating to the Survey which I commenced over one year since.

Levels have been carried to nearly all the important producing centres of the upper district, but I have not been able to connect Parker's Landing with the survey in consequence of its distance from my nearest "bench" at Venango City. I expected to have obtained the elevations along the Allegheny Valley Railway from its Chief Engineer, but have been disappointed.

Many difficulties have been encountered in getting information from well owners on whom I am entirely dependent for the data so essential to this work. Some are not willing and prompt in assisting in this way because they are under the impression that it is a private enterprise ; but the most serious obstacle met with is the characteristic indifference of the people

Digitized by Google

in the oil business to anything but that which promises an immediate personal benefit.

By means of the levels taken to the well mouths I have adjusted the records of one hundred and thirty-four wells in such a way that they all may be compared with one point. This point is the Ennis Well, Pleasantville, which is located on the highest ground in the county. All other wells are therefore below this base. The elevation of this point above tide I at first determined from information furnished me by the Smithsonian Institution to be 1761.81 feet. This result was aimed at by correcting my own levels with the levels of the Allegheny Valley Railway as I received them. But upon checking my line with other Railway Surveys, I find an error of about fifty-three feet, which I have traced to the Allegheny Valley Railway, between Venango City and Pittsburgh. This makes my base 1709 feet above tide instead of 1762 as first announced.*

In the arrangement of the strata of sandstone I have paid but little attention to the usual method of numbering, which, from the way of counting from the top is very liable to confuse, as in some places two or three mountain sands are found, and in others the first sand is the oil producing rock. I have discarded some records which were evidently incorrect, and have been forced to use some which are not altogether to be relied upon.

I have noted the elevation of 308 wells and about 80 permanent benches in different localities. I also give you the elevation above sea of several places in the western part of the state.

There have been sent out 153 blanks which have not been returned.

I have great confidence in this method of locating and defining the oil-bearing rocks, and from the data which I hand you very much can be gathered which is of practical use.

In the early part of my observations on this Survey I formed the opinion that the oil rocks dipped uniformly in one direction, but more extended surveys show differently. In some places the line of greatest dip is nearly south, while in others it is more westerly. The line of oil deposit lies almost invariably in the line of greatest dip, showing doubtless that the formation was made in swift running water, and the deposit of pebbles was in the line of the current. Hence, the "belts," which correspond with the dip.

If, in your opinion, this Survey is of any practical benefit I would suggest that it be put into the hands of the Producers' Association, with a view of making it to the interest of a larger number to assist in collecting the necessary data.

Much more work is yet required to define and locate the oil-bearing rocks in this section of the State, but the difficulties above mentioned and the lack of co-operation, together with demands on my own time which make it impossible for me to give it the attention required, have induced

* Many efforts have been made in 1874, '5 and '6 to discover the cause and quantity of this error but without the best success, although progress has been made towards its adjustment. [J. P. L.]

Digitized by Google

me to make this report and place in your hands, to use as you may deem best, all of the facts and figures thus far collected.

No part of the result has been made public, except a small sketch furnished to Dr. J. S. Newberry of the Ohio State Geological Survey.

All of which is respectfully submitted.

E. S. Nettleton, C. E.

Since my connection with the Second Geological Survey of Pennsylvania I have found these papers of great service, and been obliged to refer to them often for facts which could not now be otherwise obtained, but I did not feel at liberty to use the materials in any public way without Mr. Nettleton's consent and the acquiescence of the State Geologist. These restrictions are now removed by Mr. Nettleton's permission to publish whatever may be of general interest.

The well records are many of them imperfect, none of them indeed are just what the geologist requires, for they give no indication of the character of the strata between the Sandstones. The blanks were not prepared with a view of studying the lithology further than it was involved in an examination of the oil rocks. But they accomplished the purpose intended and brought out the facts required to demonstrate that there are different beds of sandstone lying at different horizons and all dipping with considerable uniformity to the southwest.

This may be shown in a general way by taking a few wells at random along the line surveyed from Pleasantville to Oil City—thus: (refer to the records)

(1)	Ennis Well, Pleasantville, top of oil sand above ocean		807	feet.
(87)	National, No. 2, 1½ mile southwest of Pleasantville		779	"
(127)	Fink, No. 12, Shamburg	True 3d Sand	724	"
(231)	Porter, Foster Farm, Oil Creek		678	"
(213)	G. K. Anderson, No 134, Pet Centre		631	"
(258)	Lady Suffolk, Blood Farm		588	"
(261)	Well No. 23, Rynd Farm		568	"
(268)	Champion, No. 2, Rouseville		557	"
(269)	Elizabeth, Clapp Farm		545	"
(270)	Siveily & Gardner, Allegheny Run		522	"

Between the National well and Fink, No. 12, there is a drop of about 45 feet in the figures here given from the Black oil rock or Stray, to the Green oil rock or 3d sand of Oil Creek, which accounts for what appears to be a greater dip according to the distance than on other parts of the line. The green oil rock is found under the Pleasantville district in its proper horizon as is shown by some of the well records, but is unproductive. Between the National and Shamburg both rocks yield oil in some wells. To make the whole series of ocean elevations above given uniform—that is, all referring to the top of the 3d Sand—the elevation at the National should be about 734 feet, and at Ennis' about 762 feet.

Digitized by Google

Without doubt, the general reader will be much confused in attempting to trace the oil sands in their proper order through the mass of records here given. No effort has been made to harmonize the apparent discrepancies made by drillers in numbering the Sandrocks. The records have been copied from the originals just as they were received, only making them to conform to the general plan adopted in the publication of the whole mass of records, good, bad and indifferent, which we have on hand. It will be a work for future study to select those which are reliable and to arrange and classify them in an intelligible manner. We hope that the publication of these records as they are given to us by men who claim to understand the order and arrangement of the oil rocks, will satisfy them that they are not working understandingly, and show them the necessity of a closer examination of the measures drilled through and a more careful numbering and measurement of the Sandrocks.

Mr. Nettleton's levels, as mentioned in his report, were all based on his Ennis Hill datum. In 1874 we established the height of this Hill, by levels connecting with the railways at Tidioute, Tionesta and Rouseville, as 1713 feet above tide.* We now add 7 feet to reduce this to ocean level,† making it 1720 feet above the ocean. The elevations of the following wells have all been adjusted to this standard.

All the wells not otherwise noted are located in Venango County.

Some of the records here given from Enterprise and the Columbia farm on Oil Creek have been published in a previous issue. It will be noted that these differ from the former quite materially—a circumstance which shows how unreliable, for close study, the best of records are, even when obtained from the well owners and superintendents themselves.

To make sure always that the well record sent in should be the particular one required Mr. Nettleton adopted the plan of numbering the wells in his field book as he leveled to them. He also carried with him a paint-pot and brush and marked the same number used in his note book plainly on the samson-post. This is the "engineer's number" referred to in the blanks. When the well owner returned the record he gave, in addition to the name of the well, the number on the samson-post, and thus there could be no mistake made in adjusting the levels to the record. These numbers are given in the following pages at the end of the name of the well, in brackets, thus: Ennis Well (1), Harmonial Well No. 1 (53), &c., &c.

* At Schuylkill bridge, Philadelphia, Pennsylvania Railroad datum.
† In Raritan Bay, Coast Survey datum.

Digitized by Google

I. *Wells in the Borough of Pleasantville and adjoining its east line.*

1. *Ennis Well.* (1)

October 14, 1868.

On lease No. 3, Guild & Wright tract, adjoining east line of Borough of Pleasantville. Authority, J. L. Ennis.

Well mouth above ocean (high tide) in feet					1720
?	446	to	446	=	1274
1st S. S	56	"	502	=	1218
?	168	"	670	=	1050
2d S. S	40	"	710	=	1010
?	99	"	809	=	911
3d S. S	30	"	839	=	881
?	74	"	913	=	807
4th S. S	22	"	935	=	785

Wet hole. Cased at 446′. Pumped 4 feet from the bottom.

Best production 200 barrels per day. Gas sufficient to fire 6 boilers. Black oil; gravity 43°.

2. *Swan and Belch Well, No.* 1. (57)

January 26, 1869.

S. M. Dunham Farm, lease No. 5. Canfield tract, adjoining east line of Borough of Pleasantville. Authority, Edwin Swan.

Well mouth above ocean in feet					1678
?	180	to	180	=	1498
1st S. S	15	"	195	=	1483
?	422	"	617	=	1061
2d S. S	24	"	641	=	1037
?	79	"	720	=	958
Stray S. S	25	"	745	=	933
?	15	"	760	=	918
3d S. S	28	"	788	=	890
?	72	"	860	=	818
4th S. S. pebble and sand.	9	"	869	=	809
? pocket.	23½	"	892½	=	785½

Wet hole. Cased at 407′. Pumped 12 feet from bottom.

Best production 130 barrels per day. Gas sufficient to fire three boilers. Black oil. Mud veins at 775′ and 862′.

3. *Bonta and Hawes Well, No.* 5. (60)

December, 1868.

Lease No. 4, Geroe farm, adjoining east line of Borough of Pleasantville. Authority, Charles P. Byron.

Well mouth above ocean in feet	1648

Digitized by Google

?..	215	to	215	=	1433
1st S. S..................................	12	"	227	=	1421
?..	205	"	432	=	1216
2d S. S...................................	22	"	454	=	1194
?..	203	"	657	=	991
3d S. S...................................	50	"	707	=	941
?..	135	"	842	=	806
4th S. S................................pebble.	16	"	858	=	790
?.......................................pocket.	2	"	860	=	788

Wet hole. Cased at 280′. Pumped 1⅜ feet from bottom.

Best production 120 barrels per day. Gas sufficient to fire 3 boilers. Black oil. Mud veins at 666′ and 852.′

4. *McGrew and Ritchie Well.* (5)

February 1869.

Jack Farm, McGrew, Ritchie & Co.'s tract, adjoining north-east corner of Borough of Pleasantville. Authority, James B. McClune.

Well mouth above ocean in feet................					1684
?..	135	to	135	=	1549
1st S. S..................................	85	"	220	=	1464
?..	197	"	417	=	1267
2d S. S...................................	18	"	435	=	1249
?..	194	"	629	=	1055
3d S. S...................................	24	"	653	=	1031
?..	122	"	775	=	909
4th S. S..................................	35	"	810	=	874
?..	67	"	877	=	807
5th S. S................................pebble.	11	"	888	=	796
?.......................................pocket.	8	"	896	=	788

Wet hole. Cased at 425′.

Black oil.

5. *Jack Well.* (7)

February, 1869.

Jack Farm, adjoining the north-east corner of Borough of Pleasantville. Authority, George H. Jack.

Well mouth above ocean in feet................					1680
?..	402	to	402	=	1278
1st S. S..................................	18	"	420	=	1260
?..	230	"	650	=	1030
2d S. S...................................	10	"	660	=	1020
?..	65	"	725	=	955
3d S. S...................................	30	"	755	=	925
?..	116	"	871	=	809

Digitized by Google

4th S. S.	11	"	882	=	798
? ... pocket.	7	"	889	=	791

Wet hole. Cased at 405′.

Best production 12 barrels per day. Gas sufficient to fire one boiler.

6. *Rising Sun Well.* (8)

February, 1869.

Jack Farm, adjoining north-east corner of Borough of Pleasantville. Authority, Wm. A. Barnes.

Well mouth above ocean in feet					1676
?	390	to	390	=	1286
1st S. S	28	"	418	=	1258
?	215	"	633	=	1043
2d S. S	20	"	653	=	1023
?	112	"	765	=	911
3d S. S	33	"	798	=	878
?	73	"	871	=	805
4th S. S	11	"	882	=	794
? ... pocket.	5	"	887	=	789

Wet hole. Cased at 397′. Black oil.

Best production per day 10 barrels. Gas sufficient to fire one boiler.

7. *Howe Well.* (11)

March, 1869.

Jack Farm, adjoining north-east corner of Borough of Pleasantville. Authority ———.

Well mouth above ocean in feet					1671
?	400	to	400	=	1271
2d S. S	30	"	430	=	1241
? including 3d S. S	432	"	862	=	809
4th S. S	18	"	880	=	791
? ... pocket.	6	"	886	=	785

Wet hole. Cased at 415′.

Best production 20 barrels per day. Gas sufficient to fire one boiler.

8. *Nettleton Well, No.* 1. (20)

January 17, 1866.

Nettleton tract, formerly Watkin's farm, lease No. 2, north-east corner of Borough of Pleasantville. Authority, E. S. Nettleton.

Well mouth above ocean in feet					1582
?	109	to	109	=	1473
1st S. S	121	"	230	=	1352
?	72	"	302	=	1280
2d S. S	46	"	348	=	1234

Digitized by Google

?	137	"	485	= 1097
Red Rock [redacted]	55	"	540	= 1042
3d S. S	17	"	557	= 1025
?	170	"	727	= 855
4th S. S	9	"	736	= 846
?	126	"	862	= 720
5th S. S. .... pebble and sand.	18	"	880	= 702
? .... pocket.	11½	"	891½	= 690½

Wet hole. Cased at 180′. Pumped at 22′ from bottom.

Best production 35 barrels per day. Gas sufficient to fire 4 boilers. Black oil. Gravity 44. Mud veins at 557′ and 730′. The lowest water course is at 162′. At 716′ a quartz vein was struck. Well was tested thoroughly at 736′ and 560′. At the 736′ test considerable gas was found.

9. *Richey Well, No.* 1. (15)

December, 1868.

Nettleton Farm, lease 15, Borough of Pleasantville. Authority, John Nichols.

Well mouth above ocean level..1651

?	8	to	8	= 1643
1st S. S	43	"	51	= 1600
?	330	"	381	= 1270
2d S. S	34	"	415	= 1236
?	285	"	700	= 951
3d S. S	32	"	732	= 919
?	113	"	845	= 806
4th S. S. .... pebble and sand.	17	"	862	= 789

Wet hole. Cased at 384′. Pumped 5 feet from the bottom.

Best production per day 35 barrels. Gas sufficient to fire 2 boilers. Dark green oil. Gravity 43° to 48°.

10. *Plumer Well, No.* 1. (16)

April, 1869.

Nettleton Farm, Borough of Pleasantville. Authority, ———.

Well mouth above ocean in feet..1639

?	828	to	828	= 811
4th S. S	20	"	848	= 791
? .... pocket.	2	"	850	= 789

11. *Lippincott Well, No.* 1. (18)

February, 1869

Watkin's Farm, lease 17, Borough of Pleasantville, 50 rods south of Nettleton's Well. Authority ———.

Well mouth above ocean in feet.. 1619

?	340	to	340	=	1279
2d S. S.	8	"	348	=	1271
?	232	"	580	=	1039
3d S. S.	35	"	615	=	1004
?	25	"	640	=	979
4th S. S.	25	"	665	=	954
?	30	"	695	=	924
5th S. S.	20	"	715	=	904
?	99	"	814	=	805
6th S. S.	18	"	832	=	787
? ... pocket.	8	"	840	=	779

Wet hole. Cased at 341′.

Best production 3 barrels per day. Gas sufficient to fire two boilers. Black oil. Mud vein at 700′.

12. *Blakesley Well.* (14)

November, 1868.

Brown and House Farm, situated in the Borough of Pleasantville. Authority ——.

Well mouth above ocean in feet					1672
?	400	to	400	=	1272
2d S. S. estimated	25	"	425	=	1247
?	200	"	625	=	1047
3d S. S. estimated	15	"	640	=	1032
?	70	"	710	=	962
Stray S. S.	15	"	725	=	947
?	40	"	765	=	907
4th S. S.	40	"	805	=	867
?	56	"	861	=	811
5th S. S.	19	"	880	=	792

Wet hole. Cased at 415′.

Best production 10 barrels per day. Gas sufficient to fire one boiler. Black oil.

13. *United States Petroleum Co.'s Well, No.* 27. (23)

October 9, 1868.

Brown and House Tract, Borough of Pleasantville. Authority Wm. H. Kerns.

Well mouth above ocean in feet					1676
?	392	to	392	=	1284
1st S. S.	23	"	415	=	1261
?	206	"	621	=	1055
2d S. S.	40	"	661	=	1015
?	112	"	773	=	903
3d S. S.	25	"	798	=	878

Digitized by Google

?	74	"	872	= 804
4th S. S.....Sand	15	"	887	= 789
? ......pocket.	7	"	894	= 782

Wet hole. Cased at 631′.

Best production 60 barrels per day. Gas sufficient to fire three boilers. Black oil.

14. *Harsh Well, No.* 3. (28)

October 20th, 1868.

Harsh tract, lease No. 3. Borough of Pleasantville. Authority, Samuel Harsh.

Well mouth above ocean in feet				1682
?	30	to	30	= 1652
1st S. S	40	"	70	= 1612
?	66	"	136	= 1546
2d S. S. estimated	20	"	156	= 1526
?	609	"	765	= 917
3d S. S. estimated	30	"	795	= 887
?	77	"	872	= 810
4th S. S......pebble and sand.	15	"	887	= 795
? ......pocket.	7½	"	894½	= 787½

Wet hole. Cased at 450′. Pumped 9′ from bottom.

Best Production 70 barrels per day. Gas sufficient to fire 2½ boilers. Black oil.

Struck a water course at 140′ from the surface. A dry crevice, struck at 250′ from the surface, carried off the water coming in at 140′.

15. *Shriver Well, No.* 1. (29)

October 28th, 1868.

Harsh tract, lease No. 1, Borough of Pleasantville. Authority, Albert Insinger, Jr.

Well mouth above ocean in feet				1674
?	20	to	20	= 1654
1st S. S	45	"	65	= 1609
?	545	"	610	= 1064
2d S. S	32	"	642	= 1032
?	103	"	745	= 929
3d S. S	30	"	775	= 899
?	97	"	872	= 802
4th S. S......4 feet at top pebble; bottom sand.	20	"	892	= 782
? ......pocket.	1	"	893	= 781

Wet hole. Cased at 615′. Pumped 3 feet from the bottom.

Best production 30 barrels per day. Gas sufficient to fire one boiler. Black oil. Mud veins at 760′ and 877′.

Digitized by Google

16. *Tidioute Well, No.* 1. (30)

October, 1868.

Connely Farm, Borough of Pleasantville. Authority, ———

Well mouth above ocean in feet					1670
?	410	to	410	=	1260
1st S. S	30	"	440	=	1230
?	193	"	633	=	1037
2d S. S	20	"	653	=	1017
?	102	"	755	=	915
3d S. S	30	"	785	=	885
?	82	"	867	=	803
4th S. S	17	"	884	=	786

Wet hole. Cased at 428′.

Best production 135 barrel per day. Gas sufficient to fire 2 boilers.

17. *Crocker Well.* (31)

October, 1869.

Connely tract, Borough of Pleasantville, Authority, ———.

Well mouth above ocean in feet					1675
?	408	to	408	=	1267
1st S. S	18	"	426	=	1249
?	440	"	866	=	809
4th S. S	20	"	886	=	789

Wet hole. Cased at 412′.

Best production 26 barrels per day. Gas sufficient to fire 1½ boilers. Black oil.

18. *Beam Well, No.* 1. (37)

June 25, 1868.

On land bought of T. B. Shugart, M.D., in Borough of Pleasantville. Authority, Beam Bros.

Well mouth above ocean in feet					1646
?	100	to	100	=	1546
1st S. S	12	"	112	=	1534
?	258	"	370	=	1276
2d S. S	15	"	385	=	1261
?	212	"	597	=	1049
3d S. S	28	"	625	=	1021
?	111	"	736	=	910
4th S. S	35	"	771	=	875
?	69	"	840	=	806
5th S. S.......yellow; pebble at top and middle.	17	"	857	=	789
?.......pocket.	1	"	858	=	788

Digitized by Google

Wet hole. Cased at 609. Pumped 3½ feet from bottom.

Best production 68 barrels per day. Gas sufficient to fire 18 boilers. Black oil. Mud veins at 746′ and 848′.

The sand rocks were all measured when struck and when through, with the exception of the 1st or Mt. sand, which was calculated by the length of the tools standing in the derrick and by the rope to the wrapper. Average production to January, 1869—6 months and 5 days—30 barrels per day. Tubing drawn only twice, and only four days stoppage altogether during that period. Production at January 1, 1869, 7 barrels per day.

19. *Say Well, No.* 6. (42)

November 26, 1868,

Zuver Farm, Borough of Pleasantville. Authority, Williams, Say & Co.

Well mouth above ocean in feet					1632
?	207	to	207	=	1425
1st S. S	92	"	299	=	1333
?	141	"	440	=	1192
2d S. S	20	"	460	=	1172
?	225	"	685	=	947
3d S. S	22	"	707	=	925
?	106	"	813	=	819
4th S. S	40	"	853	=	779
?	65	"	918	=	714
5th S. S pebble.	18	"	936	=	696

Wet hole. Cased at 362′. Pumped 6 feet from bottom.

Best production 15 barrels per day. Gas sufficient to fire 2 boilers. Black oil.

20. *Say Well, No.* 5. (43)

September 29, 1868.

Zuver Farm, lease No. 1, Borough of Pleasantville. Authority, Williams, Say & Co.

Well mouth above ocean in feet					1623
?	110	to	110	=	1513
1st S. S	92	"	202	=	1421
?	141	"	343	=	1280
2d S. S	20	"	363	=	1260
?	225	"	588	=	1035
3d S. S	22	"	610	=	1013
?	114	"	724	=	899
4th S. S	60	"	784	=	839
?	36	"	820	=	803
5th S. S pebble.	14	"	834	=	789

Digitized by Google

Wet hole. Cased at 356′. Pumped 5 feet from bottom.

Best production 90 barrels per day. Gas sufficient to fire 4 boilers. Black oil. Gravity 49°.

Too many holes drilled in the immediate vicinity for the good health of this well.

21. *Say Well, No. 2.* (54)

June 15, 1868.

Zuver Farm, lease No. 2, Borough of Pleasantville. Authority, Williams, Say & Co.

Well mouth above ocean in feet					1618
?	100	to	100	=	1518
1st S. S	90	"	190	=	1428
?	147	"	337	=	1281
2d S. S	20	"	357	=	1261
?	223	"	580	=	1038
3d S. S	25	"	605	=	1013
?	115	"	720	=	898
4th S. S	60	"	780	=	838
?	38	"	818	=	800
5th S. S	17	"	835	=	783

Wet Hole. Cased at 355′. Pumped 3′ from bottom.

Best production 80 barrels per day. Gas sufficient to fire 15 boilers. Black oil.

22. *Benedict Well.* (280)

February, 1869.

On Joseph Benedict's Lot, Borough of Pleasantville. Authority, C. L. Raver & Co.

Well mouth above ocean in feet					1634
?	390	to	390	=	1244
1st S. S	15	"	405	=	1229
?	197	"	602	=	1032
2d S. S	25	"	627	=	1007
?	103	"	730	=	904
3d S. S	40	"	770	=	864
?	62	"	832	=	802
4th S. S	18	"	850	=	784
? ... pocket.	5	"	855	=	779

Wet hole. Cased at 390′. Gas sufficient to fire one boiler.

Best production 3 barrels per day.

Digitized by Google

23. *Porter and Taylor Well, No.* 1. (49)

November 17, 1868.

Wm. Porter Farm, Borough of Pleasantville. Authority, Stephen Hine.

Well mouth above ocean in feet						1617
?	350	to	350	=	1267
1st S. S	25	"	375	=	1242
?	210	"	585	=	1032
2d S. S	40	"	625	=	992
?	90	"	715	=	902
3d S. S	40	"	755	=	862
?	51	"	806	=	811
4th S. S ....fine pebble.	19	"	825	=	792
? ....pocket	4½	"	829½	=	787½

Wet hole. Cased at 355′. Pumped 6 feet from bottom.

Best production per day 14 barrels. Gas sufficient to fire one boiler. Black oil.

24. *Harmonial Well, No.* 1. (53)

February 1, 1868.

Wm. Porter Farm, Borough of Pleasantville. Authority, Norman Potter, agent.

Well mouth above ocean in feet					1614
?	70	to	70	=	1544
1st S. S	12	"	82	=	1532
?	494	"	576	=	1038
2d S. S	40	"	616	=	998
?	91	"	707	=	907
3d S. S	40	"	747	=	867
?	65	"	812	=	802
4th S. S ....15′ pebble, 3′ sand.	18	"	830	=	784
Slate ....pocket.	5	"	835	=	779

Wet hole. Cased at 312′. Pumped 9 feet from bottom.

Best production 125 barrels per day. Gas sufficient to fire 3 to 4 boilers. Black oil. Gravity 47°. Mud veins in 2d, 3d and 4th sands.

Well was cased first at 380′; flowed 3 months, averaging 100 barrels per day, but running down, it finally ceased yielding oil in paying quantities November 1, 1868. It was then drilled deeper, showing the following record:

Thickness of measures to bottom of 4th S. S	830	to	830	=	784
Slate	24	"	854	=	760
5th S. S	20	"	874	=	740
? ....pocket	6	"	880	=	734

The 5th or "green oil sand," was fine, gray and muddy. It furnished a good supply of gas and some green oil, but not in sufficient quantity to pay the expenses of pumping the well.

Digitized by Google

25. *Comey and Andrews Well, No.* 1. (113)

November 9, 1868.

Lease No. 11, west part of Porter Farm, now Brown, Byers & Co. Borough of Pleasantville. Authority, Gaylord Mattison.

Well mouth above ocean in feet					1581
?	100	to	100	=	1481
1st S. S	140	"	240	=	1341
?	75	"	315	=	1266
2d S. S	25	"	340	=	1241
?	80	"	420	=	1161
3d S. S	30	"	450	=	1131
?	230	"	680	=	901
4th S. S	20	"	700	=	881
?	95	"	795	=	786
5th S. S........pebble.	18	"	813	=	768
?........pocket.	7	"	820	=	761

Wet hole. Cased at 320′. Pumped 9′ from the bottom.
Best production 8 barrels per day. Gas sufficient to fire ½ boiler. Black oil. Gravity 45°.

26. *McGrew Well, No.* 1. (70)

1868.

Brown Brothers Farm, Borough of Pleasantville. Authority, James McGrew.

Well mouth above ocean in feet					1635
?	12	to	12	=	1623
1st S. S	26	"	38	=	1597
?	338	"	376	=	1259
2d S. S	12	"	388	=	1247
?	208	"	596	=	1039
3d S. S	43	"	639	=	996
?	99	"	738	=	897
4th S. S	27	"	765	=	870
?	70	"	835	=	800
5th S. S	18	"	853	=	782
?........pocket.	2	"	855	=	780

Wet hole. Cased at 382′. Black oil. Mud veins in 4th and 5th S. S's.
The numbers given to the sands are not the proper ones, as the mountain sand should not be counted. We pumped the well at several points in the sand marked 5th S. S. as above. I do not recall how many feet of pebble sand there were.

Digitized by Google

27. *Harmonial Well, No. 2.* (95)

July 1, 1868.

Armstrong Farm, lease No. 40, three-quarters of a mile nearly south from Pleasantville Corners. Authority, Norman Potter, agent.

Well mouth above ocean in feet					1641
?	36	to	36	=	1605
1st S. S	60	"	96	=	1545
?	294	"	390	=	1251
2d S. S .... estimated.	20	"	410	=	1231
?	350	"	760	=	881
3d S. S	25	"	785	=	856
?	55	"	840	=	801
4th S. S .... sand and pebble.	16	"	856	=	785
? .... pocket.	14	"	870	=	771

Wet hole. Cased at 395′. Pumped 14 feet from bottom.

Best production 80 barrels per day. Gas sufficient to fire 2 boilers. Black oil. Gravity 45°.

The three upper rocks were very much broken up. Production at this date (December 19, 1868) 10 barrels per day.

II. *Wells in the vicinity of Pleasantville.*

28. *Baldwin and Porter Well, No.* 1. (238)

February, 1869.

On Gates Farm, Nielltown Road, three-quarters of a mile north-east of the Borough of Pleasantville. Authority, James B. McClune.

Well mouth above ocean in feet					1616
?	110	to	110	=	1506
1st S. S	90	"	200	=	1416
?	140	"	340	=	1276
2d S. S	31	"	371	=	1245
?	203	"	574	=	1042
3d S. S	21	"	595	=	1021
?	117	"	712	=	904
4th S. S	36	"	748	=	868
?	70	"	818	=	798
5th S. S	12	"	830	=	786
?	27	"	857	=	759
6th S. S .... top white pebble, bottom gray sand.	20	"	877	=	739
? .... pocket.	10	"	887	=	729

Wet hole. Cased at 353′. Gas sufficient to fire 8 boilers.

This well was tested at 840′ in the "Black oil sand," and afterwards drilled to 887′. The flow of gas came from the lower or "Green oil sand." But little oil in either of the sands.

Digitized by Google

29. *Norman Potter Well.* (308)

January 1st, 1870.

On Aaron Gates' Farm, 1 mile north-east of Pleasantville. Authority ?

Well mouth above ocean in feet					1512
?	225	to	225	=	1287
1st S. S	20	"	245	=	1267
?	215	"	460	=	1052
2d S. S	28	"	488	=	1024
?	112	"	600	=	912
3d S. S	22	"	622	=	890
? ....703′ to 707′, pebbly.	109	"	731	=	781
4th S. S ....5′ pebble. 16′ gray sand.	21	"	752	=	760
? ....pocket.	7	"	759	=	753

This well at the present time is pumping about 20 barrels of salt water per day. (Jan. 4th, 1870.)

30. *Mason Well.* (277)

1865-6.

On Prosser Farm, about 1½ miles north 80° east of Pleasantville. Authority, Jas. B. McClune.

Well mouth above ocean in feet					1551
?	90	to	90	=	1461
1st S. S	68	"	158	=	1393
?	94	"	252	=	1299
2d S. S	18	"	270	=	1281
?	228	"	498	=	1053
3d S. S	13	"	511	=	1040
?	69	"	580	=	971
4th S. S	20	"	600	=	951
?	30	"	630	=	921
5th S. S	28	"	658	=	893
?	134	"	792	=	759
6th S. S	10	"	802	=	749
? ....pocket.	3	"	805	=	746

Wet hole. Cased at 260′. Green Oil show.
Mud veins at 582′ and 634′.

31. *Fobes Well.* (278)

Fall of 1865.

Dunham Farm, 1½ miles east of Pleasantville. Authority, George C. Fobes.

Well mouth above ocean in feet					1521
?	85	to	85	=	1436
1st S. S	55	"	140	=	1381

Digitized by Google

?	79	to	219	=	1302
2d S. S	34	"	253	=	1268
?	284	"	537	=	984
3d S. S	31	"	568	=	953
?	35	"	603	=	918
4th S. S	28	"	631	=	890
?	86	"	717	=	804
5th S. S	2	"	719	=	802
?	15	"	734	=	787
6th S. S	11	"	745	=	776
?	96	"	841	=	680
Sand, shales and pebbles	24	"	865	=	656
?	11	"	876	=	645
Red Rock	57	"	933	=	588
Slate	107	"	1040	=	481
Red Rock	10	"	1050	=	471

Wet hole. Cased at —. Mud veins at 507′ and 597′.

This well was tested at 650′, and then drilled to its present depth and tested again, with but little show of oil at either point.

32. *Steele Well, No.* 1. (120)

November, 1868.

Benj. Tyrrell Farm, 1¼ miles south-east of Pleasantville, near Ledsham Well. Authority, ———.

Well mouth above ocean in feet					1566
?	620	to	620	=	946
3d S. S	37	"	657	=	909
?	115	"	772	=	794
5th S. S ... pebble.	17	"	789	=	777
? ... pocket.	7	"	796	=	770

Wet hole. Cased at 318′. Pumped 24 feet from bottom.

Best production 8 barrels per day. Black oil.

33. *Ledsham Well, No.* 1. (121)

November, 1866.

S. Q. Brown and Porter (or B. Tyrrel) Farm, 1¼ mile south-east of Pleasantville. Authority, Alfred Ledsham.

Well mouth above ocean in feet					1550
?	97	to	97	=	1453
1st S. S	18	"	115	=	1435
?	141	"	256	=	1294
2d S. S	58	"	314	=	1236
?	170	"	484	=	1066
3d S. S	41	"	525	=	1025

Digitized by Google

?	58	to	583	=	967
4th S. S.	73	"	656	=	894
?	74	"	730	=	820
5th S. S. brown coarse pebble.	13	"	743	=	807
?	27	"	770	=	780
6th S. S. pebble.	20	"	790	=	760
? pocket.	28	"	818	=	732

Wet hole. Cased at 300′. Pumped 15′ from bottom.

Best production 16 barrels per day. Half enough gas to fire one boiler. Black oil. Gravity 44°.

The 4th S. S. consists of two layers with a small stratum of slate intervening about the middle (say 10′ of slate). The 5th S. S. is of uniform texture throughout. The 6th S. S. is white, and finer than the 5th S. S.

34. *Terry Well.* (125)

Bean Farm, 2¾ miles south-east of Pleasantville, near Farmers' Hotel. Authority, ———.

Well mouth above ocean in feet					1487
?	203	to	203	=	1284
1st S. S.	28	"	231	=	1256
?	196	"	427	=	1060
2d S. S.	26	"	453	=	1034
?	72	"	525	=	962
3d S. S.	20	"	545	=	942
?	25	"	570	=	917
4th S. S.	18	"	588	=	899
?	90	"	678	=	809
5th S. S.	14	"	692	=	795
? pocket.	1	"	693	=	794

Wet hole. Black oil.

Wells have been put down deeper in the vicinity of this well which find 27′ of slate between the two lower sands, the 5th and 6th.

35. *Golden Well, No.* 2. (165)

February, 1868.

Pithole Golden and Cherry Run Petroleum Company's Golden Farm, 2 miles south of Pleasantville. Authority, John F. Carll.

Well mouth above ocean in feet					1551
?	72	to	72	=	1479
1st S. S.	75	"	147	=	1404
?	151	"	298	=	1253
2d S. S.	17	"	315	=	1236
?	131	"	446	=	1105

Digitized by Google

3d S. S.	11	to	457	=	1094
?	79	"	536	=	1015
4th S. S.	19	"	555	=	996
?	61	"	616	=	935
5th S. S.	21	"	637	=	914
?	32	"	669	=	882
6th S. S.	21	"	690	=	861
?	79	"	769	=	782
7th S. S. ....pebble and sand.	15	"	784	=	767
? ....pocket.	1	"	785	=	766

Wet hole. Cased at 300′. Pumped 2′ from bottom.

Best production 7 barrels per day. Half enough gas to fire a boiler. Black oil. Gravity 47°. Mud veins at 678′ and 777′.

36. *North Star Well, No.* 2. (163)

January 9, 1869.

Lease No. 1, North Star Company's "Clark Farm," 1½ miles south of Pleasantville. Authority, T. Chattle.

Well mouth above ocean in feet					1611
?	153	to	153	=	1458
1st S. S.	20	"	173	=	1438
?	172	"	345	=	1266
2d S. S.	25	"	370	=	1241
?	260	"	630	=	981
3d S. S.	62	"	692	=	919
?	23	"	715	=	896
4th S. S.	35	"	750	=	861
?	65	"	815	=	796
5th S. S.	12	"	827	=	784

Wet hole. Cased at 347′. Pumped 3′ 6″ from bottom.

Best production 35 barrels per day. Gas sufficient to fire one boiler. Dark oil. Mud veins 740′ and 822′.

37. *Hoozier Well.* (287)

1865.

At Dawson Centre, Pithole Creek, 1½ miles above Pithole City, and 4 miles south of Pleasantville. Authority, Norman R. Bates.

Well mouth above ocean in feet					1357
?	124	to	124	=	1233
1st S. S.	24	"	148	=	1209
?	209	"	357	=	1000
2d S. S.	24	"	381	=	976
?	76	"	457	=	900
3d S. S.	30	"	487	=	870

Digitized by Google

?..	103	to	590	=	767
4th S. S..	20	"	610	=	747
?.......................................pocket.	33	"	643	=	714

Best production 15 barrels per day. Green oil.

38. *Skidmore Well.* (293)

April, 1869.

McBride Farm, "Tip Top," 2½ miles south of Pleasantville. Authority?

Well mouth above ocean in feet..					1622
?..	787	to	787	=	835
4th S. S..	25	"	812	=	810
?..	63	"	875	=	747
5th S. S..	22	"	897	=	725
?.......................................pocket.	3	"	900	=	722

Wet hole. Cased at 420′.

Best production 35 barrels per day. Half enough gas to fire a boiler. Black oil.

This well is supposed to be pumping from the same as the 4th rock in Pleasantville, but the oil is of lighter color.

39. *Black Well.* (292)

Lease No. 25, Winslow Petroleum Co., "Tip Top," 2½ miles south of Pleasantville. Authority, Mr. Loud, Superintendent.

Well mouth above ocean in feet..					1530
?..	118	to	118	=	1412
1st S. S..	65	"	183	=	1347
?..	123	"	306	=	1224
2d S. S..	34	"	340	=	1190
?..	200	"	540	=	990
3d S. S..	16	"	556	=	974
?..	14	"	570	=	960
4th S. S..	26	"	596	=	934
?..	37	"	633	=	897
5th S. S..	22	"	655	=	875
?..	43	"	698	=	832
6th S. S..	25	"	723	=	807
?..	67	"	790	=	740
7th S. S.......................................pebble.	5	"	795	=	735
?..	3	"	798	=	732
8th S. S.......................................pebble.	6	"	804	=	726
?.......................................pocket.	10	"	814	=	716

Wet hole.

Best production 1 barrel per day. Half enough gas to fire a boiler.

Digitized by Google

40. *Olive Well.* (182)

1865.

Herbert Tract, Mill Farm, 2¼ miles south of Pleasantville. Authority?

Well mouth above ocean in feet					1486
?	202	to	202	=	1284
1st S. S.	38	"	240	=	1246
?	130	"	370	=	1116
2d S. S.	5	"	375	=	1111
?	155	"	530	=	956
3d S. S.	10	"	540	=	946
?	97	"	637	=	849
4th S. S.	21	"	658	=	828
?	77	"	735	=	751
5th S. S.	15	"	750	=	736
?	10	"	760	=	726
6th S. S. pebble and sand.	12	"	772	=	714
? pocket.	29	"	811	=	685

Wet hole. Not cased. Seed bag at 480′.
Black oil. Gravity 45°.

41. *Buffalo Well, No.* 1. (181)

December 26th, 1866.

Lease A, (10 acres,) Mill Farm, 1¾ miles south of Pleasantville. Authority, Wm. Williams & S. Simpkins.

Well mouth above ocean in feet					1486
?	60	to	60	=	1426
1st S. S.	50	"	110	=	1376
?	150	"	260	=	1226
2d S. S.	25	"	285	=	1201
?	240	"	525	=	961
3d S. S.	15	"	540	=	946
?	50	"	590	=	896
4th S. S.	20	"	610	=	876
?	130	"	740	=	746
5th S. S. pebble and sand.	16	"	756	=	730

Wet hole. Cased at 535′. Pumped 7′ from bottom.
Best production 4 barrels per day. Half enough gas to fire 1 boiler. Black oil. Gravity 47°.

This well is supposed to be flooded by several old abandoned wells in the immediate vicinity. Have pumped in 27 days 42 barrels of roily oil, green and black, principally black.

Digitized by Google

42. *Snyder Well, No.* 1. (180)

December, 1868.

Lease No. 3, Mill farm, 1¾ miles south of Pleasantville. Authority, J. C. Champion.

Well mouth above ocean in feet					1510
?	50	to	50	=	1460
1st S. S	40	"	90	=	1420
?	165	"	255	=	1255
2d S. S	25	"	280	=	1230
?	130	"	410	=	1100
3d S. S	25	"	435	=	1075
?	70	"	505	=	1005
4th S. S	20	"	525	=	985
?	70	"	595	=	915
5th S. S	14	"	609	=	901
?	31	"	640	=	870
6th S. S	20	"	660	=	850
?	80	"	740	=	770
7th S. S	18	"	758	=	752
? ... pocket.	2	"	760	=	750

Wet hole. Cased at 275′. Pumped 8′ from bottom.

Best production 90 barrels per day. Gas sufficient to fire 1 boiler. Black oil. Gravity 48°. Mud veins in both the lower sands.

43. *Bates Well, No.* 1. (102)

—— —— 1866

Dawson Farm, 1⅓ miles south of Pleasantville. Authority, N. R. Bates.

Well mouth above ocean in feet					1587
?	560	to	560	=	1027
3d S. S. estimated	30	"	590	=	997
?	50	"	640	=	947
4th S. S	30	"	670	=	917
?	122	"	792	=	795
5th S. S ... fine pebble and sand.	13	"	805	=	782
? ... pocket.	15	"	820	=	767

Wet hole. Cased at 400′. Pumped 20′ from bottom.

Black oil. Gravity 47°, when first pumped.

At one time during the first ninety days of the production the well yielded at the rate of 500 barrels per day, and was running at this rate when the men, in the excitement occasioned by so great a flow of oil, "shut down" to connect with a larger tank. This seemed to check the flow so effectually that the well could never again be brought up to its former production. The first part of the record was lost. My driller re-

Digitized by Google

ported *lime* and sand for 30′ above the 5th S. S. Overlying this was a stratum of *soapstone* more than 20′ thick, in which was a *crevice* or cavity 5′ in depth, then 3 of soapstone, then a *cavity* of 11′ in depth, as measured by pole tools.*

44. *Bates Petroleum Co. Well, No. 3.* (119)

Fall and Winter of 1866.

Matteson Farm, Pleasantville and Enterprise road, half a mile north of Pleasantville. Authority, N. R. Bates.

Well mouth above ocean in feet					1463
?	175	to	175	=	1288
1st S. S.	40	"	215	=	1248
?	201	"	416	=	1047
2d S. S.	40	"	456	=	1007
?	105	"	561	=	902
3d S. S.	33	"	594	=	869
?	84	"	678	=	785
4th S. S. ....inferior, gray.	12	"	690	=	773
?	10	"	700	=	763
5th S. S. ....close, some pebbles.	20	"	720	=	743
? ....pocket.	10	"	730	=	733

Wet hole. Cased at 190.

Best production half barrel per day. Gas sufficient to fire half boiler. Green oil.

When this well was first tested, after a few days of pumping, it showed very well, giving considerable gas and throwing at intervals a full pipe of oil. At this time an accident occurred, fastening the working valve so as to necessitate the drawing of the tubing. As the well was not cased at this time it seemed to be injured very much by the letting in of the water, and never again made so good a show as at first.

45. *Paschmacker Well.* (198)

1868.

Near school house on Pleasantville and Enterprise road, 1 mile north of Pleasantville. Authority, M. P. Barber.

Well mouth above ocean in feet					1586
?	306	to	306	=	1280
1st S. S.	21	"	327	=	1259
?	53	"	380	=	1206
2d S. S.	26	"	406	=	1180

* As these well records are here merely placed on record no comment is made on such extraordinary (or rather, ordinary) statements. The literature of oil is full of them. They are mostly based on errors of observation easily explained. [J. P. L.]

Digitized by Google

?..	284	to	690	=	896
3d S. S..	20	"	710	=	876
?..	110	"	820	=	766
4th S. S..	21	"	841	=	745
?................................pocket.	114	"	955	=	631

Wet hole.

Best production —. Green oil. Little gas. Red water.

46. *Eaton Well.* (289)

April, 1869.

On lease No. 1, J. Y. Siggins Farm, 1 mile north-west of Pleasantville. Authority, James Y. Siggins.

Well mouth above ocean in feet..............................					1668
?..	140	to	140	=	1528
1st S. S..	35	"	175	=	1493
?..	45	"	220	=	1448
2d S. S..	50	"	270	=	1398
?..	373	"	643	=	1025
3d S. S..	40	"	683	=	985
?..	97	"	780	=	888
4th S. S................................pebble.	20	"	800	=	868
?..	121	"	921	=	747
5th S. S....................................sand	12	"	933	=	735
?................................pocket.	9	"	942	=	726

Wet hole. Cased at 450′. Mud veins at centre of 3d and 4th sands.

Best production 2 gallons per day. Green oil.

About 10′ of the top of the 4th S. S. was pebbly and ought to have produced oil, if immediately tested, but the well was drilled to the 5th sand before the tubing was put in. This sand was white and close, with no pebbles.

47. *Siggins Well.* (291)

November, 1868.

James Y. Siggins Farm, 1 mile north-west of Pleasantville. Authority, James Y. Siggins.

Well mouth above ocean in feet..............................					1535
?..	95	to	95	=	1440
1st S. S..	40	"	135	=	1400
?..	125	"	260	=	1275
2d S. S..	37	"	297	=	1238
?..	219	"	516	=	1019
3d S. S..	42	"	558	=	977
?..	103	"	661	=	874

Digitized by Google

4th S. S.	15	to	676	=	859
?	104	"	780	=	755
5th S. S.	19	"	799	=	736
?	81	"	880	=	655

Wet hole.

The 4th S. S. was a splendid pebble rock with excellent show of oil. Got the sand pump stuck in drilling and had to drill it out, and this is thought to have spoiled the well.

48. *Smythe Well.* (118)

1869.

John McCaslin Farm, 1 mile west of Pleasantville. Authority, ——.

Well mouth above ocean in feet					1608
?	142	to	142	=	1466
1st S. S.	66	"	208	=	1400
?	128	"	336	=	1272
2d S. S.	36	"	372	=	1236
?	208	"	580	=	1028
3d S. S.	42	"	622	=	986
?	98	"	720	=	888
4th S. S.	29	"	749	=	859
?	110	"	859	=	749
5th S. S. ... gray sand.	19	"	878	=	730
? ... pocket.	5	"	883	=	725

Wet hole. Cased at 375′.

No paying production. The well was tested at 749′, where some black oil was obtained. Afterwards the well was put down to the next (5th) S. S., from which it produced very little green oil.

49. *Horseshoe Well, No.* 1. (117)

July, 1866.

On Pithole, Golden and Cherry Run Oil Co.'s tract, 1¼ miles south-west of Pleasantville. Authority, John F. Carll.

Well mouth above ocean in feet					1553
?	135	to	135	=	1418
1st S. S.	30	"	165	=	1388
?	120	"	285	=	1268
2d S. S.	35	"	320	=	1233
?	220	"	540	=	1013
3d S. S.	28	"	568	=	985
?	106	"	674	=	879
4th S. S.	27	"	701	=	852

Digitized by Google

?........	104	"	805	=	748
5th S. S......................sand and pebble.	35	"	840	=	713

Wet hole. Cased at 300′. Pumped 10′ from bottom.

Best production a few gallons per day. Green oil. Gas sufficient to fire 2 boilers.

Mud veins at 540′, 695′, and 765′.

50. *Children's Well, No.* 1. (97)

November 4, 1868.

Armstrong Farm, lease 101, adjoining Brown Bros. tract, ½ mile south of the Borough of Pleasantville. Authority, ——.

Well mouth above ocean in feet					1638
?..	834	to	834	=	804
4th S. S......................pebble and sand.	12	"	846	=	792
?..................................pocket.	14	"	860	=	778

Wet hole. Cased at 418′.

Best production 42 barrels per day. Gas sufficient to fire 3 boilers. Black Oil.

51. *Brown and Warner Well.* (110)

March, 1868.

Armstrong Farm, lease No. 89, ½ mile south of Pleasantville. Authority?

Well mouth above ocean in feet....					1579
?..	328	to	328	=	1251
1st S. S..	30	"	358	=	1221
?..	427	"	785	=	794
4th S. S..	18	"	803	=	776

Wet hole. Cased at 340′. Black Oil.

Best production 90 barrels per day.

52. *Maple Shade Well, No.* 1. (105)

July 7th, 1868.

Brown, Fertig and Hammond tract, 1¼ miles south of Pleasantville. Authority, ——.

Well mouth above ocean in feet..					1555
?..	768	to	768	=	787
4th S. S..	18	"	786	=	769
?..................................pocket.	6	"	792	=	763

Wet hole. Cased at 418′.

Best production 150 barrels per day. Gas sufficient to fire 4 boilers. Black Oil.

This record is unreliable.

Digitized by Google

53. *Holbrook Well, No.* 1. (81)

August, 1866.

New York and Providence Petroleum Co. farm, 1 mile south-west of Pleasantville Corners. Authority, R. W. Holbrook.

Well mouth above ocean in feet					1540
?	104	to	104	=	1436
1st S. S	47	"	151	=	1389
?	147	"	298	=	1242
2d S. S	20	"	318	=	1222
?	205	"	523	=	1017
3d S. S	27	"	550	=	990
?	110	"	660	=	880
4th S. S	22	"	682	=	858
?	74	"	756	=	784
5th S. S ... pebble.	24	"	780	=	760
?	15	"	795	=	745
6th S. S	30	"	825	=	715
? ... pocket.	15	"	840	=	700

Wet hole. Cased at 325′. Pumped 72 feet from bottom.

Best production 15 barrels per day. Gas sufficient to fire 2 boilers. Black oil. Gravity 42°.

The 6th sandrock was found to be a hard close white sand. The well has been tubed from 756 feet to 816 feet, with same result. Good show of oil and gas in the 4th S. S.

54 *Concordia Well.* (174)

1868

North-east part of James Farrel Farm, lease No. 1, 1¾ miles south-west of Pleasantville. Authority, ———.

Well mouth above ocean in feet					1578
? ... pocket.	100	to	100	=	1478
1st S. S	80	"	180	=	1398
?	180	"	360	=	1218
2d S. S	28	"	388	=	1190
?	212	"	600	=	978
3d S. S	18	"	618	=	960
?	192	"	810	=	768
4th S. S	27	"	837	=	741
?	10	"	847	=	731
5th S S ... sand.	40	"	887	=	691

Wet hole. Cased at 350′.

Best production a "good show" of green oil. Mud vein at 815′.

Digitized by Google

55. *Baum Well, No.* 1. (175)

186?.

South-east part of north half of J. Farrell Farm, 1½ miles south-west of Pleasantville. Authority, Grant Parkhurst.

Well mouth above ocean in feet					1573
?	90	to	90	=	1483
1st S. S	100	"	190	=	1383
?	154	"	344	=	1229
2d S. S	20	"	364	=	1209
?	216	"	580	=	993
3d S. S	21	"	601	=	972
?	179	"	780	=	793
4th S. S	18	"	798	=	775
?	36	"	834	=	739
5th S. S	38	"	872	=	701
? pocket.	15	"	887	=	686

Wet hole. Cased at 360′.

Best production 3 barrels per day. Half enough gas to fire one boiler. Black oil in 4th S. S., and green oil in 5th S. S. Gravity, black oil 48°, and green oil 46°.

The above well was drilled in the winter of 1867 8; was tested at 810′ and failed to produce oil in paying quantities; was then drilled to the depth of 878′ with the same result. Yellow pebble at 800′, white pebble at 835′. The well has since been abandoned. I do not think it was ever properly tested at 844′ or in the 5th S. S.

56. *Phœnix Well, No.* 1. (86)

August, 1868.

Bates Petroleum Co. tract, 1½ miles south-west of Borough of Pleasantville. Authority, ———.

Well mouth above ocean in feet					1520
?	80	to	80	=	1440
1st S. S	56	"	136	=	1384
?	131	"	267	=	1253
2d S. S	20	"	287	=	1233
?	218	"	505	=	1015
3d S. S	15	"	520	=	1000
?	120	"	640	=	880
4th S. S	25	"	665	=	855
?	74	"	739	=	781
5th S. S pebble and sand	36?	"	775	=	745

Wet hole. Cased at 510′.

Best production 90 barrels per day. Gas sufficient to fire 2 boilers. Black oil.

Digitized by Google

[The record of this well, as given in the blank, from the top of the 5th S. S. down is evidently wrong. It is as follows:

Top of 5th S. S.	739′
Thickness	28′
Top of 6th S. S.	761′
Thickness	14′
Depth of well	775′]

57. *National Well, No. 2.* (87)

National Oil Co. tract, 1½ miles south-west of Borough of Pleasantville. Authority, E. L. Pitcher.

Well mouth above ocean in feet					1526
?	101	to	101	=	1425
1st S. S.	29	"	130	=	1396
?	150	"	280	=	1246
2d S. S.	32	"	312	=	1214
?	226	"	538	=	988
3d S. S.	21	"	559	=	967
?	41	"	600	=	926
4th S. S.	69	"	669	=	857
?	78	"	747	=	779
5th S. S. pebble.	15	"	762	=	764
? pocket.	7	"	769	=	757

Wet hole. Cased at 300′. Pumped 7 feet from bottom.

Best production 83 barrels per day. Gas sufficient to fire 1½ boilers. Black oil. Gravity 49°. The 4th S. S. is broken by 20 feet of slate and shelly rock.

III. *Wells at Shamburg and Vicinity.*

---

58. *Pierson Well.* (177)

1869.

King lot, three-quarters of a mile north-east of Shamburg. Authority, William Morgan.

Well mouth above ocean in feet					1584
?	149	to	149	=	1435
1st S. S.	60	"	209	=	1375
?	147	"	356	=	1228
2d S. S.	23	"	379	=	1205
?	241	"	620	=	964
3d S. S.	12	"	632	=	952

Digitized by Google

?	98	to	730	=	854
4th S. S.	25	"	755	=	829
?	77	"	832	=	752
5th S. S. ....pebble at top.	10	"	842	=	742
? ....pocket.	13	"	855	=	729

Wet hole. Cased at 360′.

Best production 10 barrels per day. Half enough gas to fire one boiler. Black oil.

59. *Emory Well, No.* 2. (307)

August, 1869.

Walter Scott Petroleum Company's tract, adjoining C. Clark Farm, half mile east of Shamburg. Authority, ———.

Well mouth above ocean in feet........ 1641

?	900	to	900	=	741
5th S. S.	18	"	918	=	723
?	12	"	930	=	711
6th S. S. ....pebble and sand.	35	"	965	=	676
?	7	"	972	=	669

Wet hole. Cased at ——.

Best production 80 barrels per day. Gas sufficient to fire one boiler. Green oil.

This well was put down and tested in the 5th S. S., and obtained black oil in small quantities; was afterwards put deeper. This 6th rock is evidently the one called the 5th in Shamburg.

60. *Oak Shade Well, No.* 1. (128)

September 10, 1868.

Clark Farm, ten acre lease, near Shamburg. Authority, George W. Arnold, Supt.

Well mouth above ocean in feet........ 1545

?	120	to	120	=	1425
1st S. S.	93	"	213	=	1332
?	117	"	330	=	1215
2d S. S.	30	"	360	=	1185
?	226	"	586	=	959
3d S. S.	14	"	600	=	945
?	104	"	704	=	841
4th S. S.	13	"	717	=	828
?	83	"	800	=	745
5th S. S. ....pebble and sand.	65	"	865	=	680

Wet hole. Cased at 345′. Pumped 23′ from bottom.

Best production 40 barrels per day. No gas of any account. Black oil. Gravity 36° or 37°. Mud veins at 590′ and 850′.

This well was not drilled through the 5th S. S. From other wells near

Digitized by Google

by we judge there remain 15′ more of sand, which would make the entire thickness of the sand 65′ + 15′ = 80′. The well from the time it was struck has averaged 25 barrels per day. [Jan. 1869.]

61. *Lady Jane Well. No.* 1. (129)

December 13, 1868.

Clark Farm, 5 acre lease, near Shamburg. Authority, Arnold & Lockwood.

Well mouth above ocean in feet					1539
?	120	to	120	=	1419
1st S. S	116	"	236	=	1303
?	90	"	326	=	1213
2d S. S	39	"	365	=	1174
?	213	"	578	=	961
3d S. S	22	"	600	=	939
?	98	"	698	=	841
4th S. S	36	"	734	=	805
?	66	"	800	=	739
5th S. S. pebble and sand	73	"	873	=	666

Wet hole. Cased at 347′. Pumped 22′ from bottom.

Best production 20 barrels per day. Not gas enough to fire a boiler. Black oil. Gravity 36° or 37°. Mud veins at 340′, 720′, 810′, and 850′. The well was not drilled through the 5th sand by 15′ or 20′. Small division of slate in this sand.

62. *Lockwood Well, No.* 1. (131)

September 20, 1866.

Clark Farm, near Shamburg. Authority, E. M. & T. J. Lockwood.

Well mouth above ocean in feet					1492
?	103	to	103	=	1389
1st S. S	40	"	143	=	1349
?	139	"	282	=	1210
2d S. S	29	"	311	=	1181
?	219	"	530	=	962
3d S. S	7	"	537	=	955
?	105	"	642	=	850
4th S. S	35	"	677	=	815
?	108	"	785	=	707
5th S. S. pebble and sand	46	"	831	=	661
? pocket	11	"	842	=	650

Wet hole. Cased at 300′. Pumped 40′ from bottom.

Best production 6 barrels per day. Half enough gas to fire one boiler. Color of oil between black and green. Gravity 37°. Mud vein at 645′.

The Lockwood Well showed evidences of being on the outskirts of the black oil bearing rock, as it produced a large quantity of salt water, and the Shamburg well in close proximity produced light green oil.

Digitized by Google

63. *Fink Well.* (127)

February 22, 1867.

On lease No. 12, Pittsburgh and Cherry Run Oil Company, Shamburg. Authority, John J. B. Fink.

Well mouth above ocean in feet					1500
?	70	to	70	=	1430
1st S. S ......white sand, 60′, gray sand 22′ =	82′	"	152	=	1348
?	137	"	289	=	1211
2d S. S., white sand and pebbles 16′, gray sand 30′=	46	"	335	=	1165
?	185	"	520	=	980
3d S. S	25	"	545	=	955
?	95	"	640	=	860
4th S. S....pebbly at top, bottom fine and white	28	"	668	=	832
?	108	"	776	=	724
5th S. S......loose open rock.	57′	"	833	=	667
? ......pocket.	2	"	835	=	665

Wet hole. Cased at 340′. Pumped 15′ from bottom.

Best production, 210 barrels per day. Green oil. Gravity 48°. Gas sufficient to fire from 4 to 6 boilers. Mud veins at 530′, 645′ and 806′. Crevice at 778′.

We are troubled a great deal with mud running into the well at 806′. The well is still producing, and could be made to pump 20 barrels per day if we could exhaust the mud, and keep the well clean [Jan. 1st, 1869].

There are shells ranging in thickness, between the regular Sandrocks which I could not give in this blank.

64. *Fink Well, No.* 1. (147)

May 5th, 1867.

Farm of Huidekoper Petroleum Co. of N. Y., lease No. 1, 10 acres, Shamburg. Authority, John J. B. Fink.

Well mouth above ocean in feet					1510
?	100	to	100	=	1410
1st S. S	72	"	172	=	1338
?	126	"	298	=	1212
2d S. S	24	"	322	=	1188
?	206	"	528	=	982
3d S. S	33	"	561	=	949
?	96	"	657	=	853
4th S. S	42	"	699	=	811
?	95	"	794	=	716
5th S. S......pebble at top and bottom.	49	"	843	=	667

Wet hole. Cased at 325′. Pumped 15′ from bottom.

Best production 75 barrels per day. Gas sufficient to fire 2 boilers. Light green oil. Gravity 46° to 47°.

The oil rock has a 7′ shell above it.

This well was finished May 3d, 1867. The well will produce an average

Digitized by Google

of from 10 to 15 barrels per day now, January, 1869. I have two more wells on this same lease, and their records do not vary much from this one. One is now averaging from 25 to 40 barrels per day, and the other about 6 barrels.

65. *Fee Well, No.* 1. (139)

December 23, 1867.

Atkinson Farm, lease 106, Shamburg. Authority, F. E. Hammond.

Well mouth above ocean in feet					1533
?	817	to	817	=	716
5th S. S. .... pebble and sand.	45	"	862	=	671

Wet hole. Not cased. Seed bag at 322′. Pumped 20′ from bottom.

Best production 512 barrels per day. Gas sufficient to fire 6 boilers. Green oil. Gravity $47\frac{1}{2}^{\circ}$.

This well ceased producing October, 1868. The total production was $49,262\frac{44}{100}$ barrels. The largest production was in the month of May, being 11,200 barrels.

66. *Jack Brown Well, No.* 1. (140)

December 27th, 1867.

Atkinson Farm, lease 108, Shamburg. Authority, F. E. Hammond.

Well mouth above ocean in feet					1533
?	98	to	98	=	1435
1st S. S	100	"	198	=	1335
?	112	"	310	=	1223
2d S. S	25	"	335	=	1198
?	221	"	556	=	977
3d S. S	13	"	569	=	964
?	110	"	679	=	854
4th S. S	25	"	704	=	829
?	111	"	815	=	718
5th S. S. .... pebble and sand.	40	"	855	=	678

Wet hole. Cased at 320′. Pumped 3′ from bottom.

Best production 441 barrels per day. Gas supplied at one time 15 boilers. Green oil. Gravity $47\frac{1}{2}^{\circ}$. Mud vein at 830′.

This well ceased to produce August 17th, 1868. The total production was $65,916\frac{93}{100}$ barrels, averaging $284\frac{13}{100}$ barrels per day from the commencement of production to the close. The average price paid for this oil was \$2.52 per barrel at the well. During the month of April, 1868, it produced 14,500 barrels, and the same was delivered to Pipe Co., averaging $483\frac{1}{3}$ barrels daily.

Digitized by Google

67. *Skinner Well, No* 1. (142)

April, 1868.

Lease No. 100, Atkinson Farm, Shamburg. Authority, F. E. Hammond.

Well mouth above ocean in feet					1537
?	101	to	101	=	1436
1st S. S.	100	"	201	=	1336
?	110	"	311	=	1226
2d S. S.	25	"	336	=	1201
?	222	"	558	=	979
3d S. S.	13	"	571	=	966
?	199	"	770	=	767
4th S. S.	25	"	795	=	742
?	23	"	818	=	719
5th S. S. pebble and sand.	45	"	863	=	674
? pocket.	5	"	868	=	669

Wet hole. Not cased. Seed bag at 330′. Pumped 18′ from bottom.

Best production 150 barrels per day. Gas sufficient to fire 2 boilers. Green oil. Gravity 47½°. Mud vein at 828′.

This well produced 11,611$\frac{38}{100}$ barrels of oil, 43 gallons to the barrel. This was sold at an average price of $3.81 per barrel. Well ceased to produce October, 1868.

68. *Hammond Brothers Well, No.* 1. (144)

January, 1869.

Lease 42, Atkinson Farm, Shamburg. Authority, F. E. Hammond.

Well mouth above ocean in feet					1575
?	142	to	142	=	1433
1st S. S.	100	"	242	=	1333
?	135	"	377	=	1198
2d S. S.	25	"	402	=	1173
?	196	"	598	=	977
3d S. S.	13	"	611	=	964
?	107	"	718	=	857
4th S. S.	40	"	758	=	817
?	100	"	858	=	717
5th S. S. pebble and sand.	45	"	903	=	672
? pocket.	7	"	910	=	665

Wet hole. Cased at 375′. Pumped 5′ from bottom.

Best production 40 barrels per day. Half enough gas to fire a boiler. Green-oil. Gravity 47½°.

69. *Tallman Farm Well, No.* 2. (135)

November, 1868.

Lease No. 2, Tallman Farm, near Shamburg. Authority, Lyman Stewart.

Well mouth above ocean in feet					1501
?	70	to	70	=	1431
1st S. S.	80	"	150	=	1351
?	140	"	290	=	1211
2d S. S.	15	"	305	=	1196
?	225	"	530	=	971
3d S. S.	25	"	555	=	946
?	110	"	665	=	836
4th S. S.	40	"	705	=	796
?	90	"	795	=	706
5th S. S. ....Sandy.	43	"	838	=	663
? ....pocket.	14	"	852	=	649

Wet hole. Cased at 300′. Pumped 12′ from bottom.

Best production 8 barrels per day. Gas sufficient to fire one boiler. Green oil. Gravity 46°. Mud veins at 673′ and at 828′.

At 511′ shelly rock; at 643′ crevice of 3″. From 643′ to 671′ we find crevices of from 2″ to 8″, about 10′ apart; at 672′ a broken rock, and at 677′ a small crevice; at 770′ a crevice of 3″; at 788′ rough rock. From 801′ to 804′ pebble rock. 5th S. S. rough and broken, with small crevices. No discovery of effects of torpedo on rock, neither did they (we put in 5) improve materially the production.

NOTE.—The above measurements are taken from Dale's crevice searcher's record, and from the driller's memoranda.

70. *Andrews and Stuart Well, No.* 1. (149)

Lease 86, Tallman Farm, Shamburg. Authority, ——.

Well mouth above ocean in feet					1532
?	85	to	85	=	1447
1st S. S.	80	"	165	=	1367
?	145	"	310	=	1222
2d S. S.	35	"	345	=	1187
?	205	"	550	=	982
3d S. S.	15	"	565	=	967
?	115	"	680	=	852
4th S. S.	40	"	720	=	812
?	90	"	810	=	722
5th S. S. ....pebble.	50	"	860	=	672

Wet hole. Cased at 320′. Pumped 4′ from bottom.

Best production 300 barrels per day. Gas sufficient to fire 5 boilers. Green oil. Gravity 43° to 45°. Mud veins at 688′, 712′, 820′ and 850′.

71. *Chatfield and Tomlinson Well, No* 1. (183)

March, 1867.

Lease No. 12. Henderson Farm, Upper Cherry Run, half mile south of Shamburg. Authority, Chatfield and Tomlinson

Well mouth above ocean in feet					1530
?	100	to	100	=	1430
1st S. S	95	"	195	=	1335
?	135	"	330	=	1200
2d S. S	30	"	360	=	1170
?	290	"	650	=	880
3d S. S	20	"	670	=	860
?	30	"	700	=	830
4th S. S	40	"	740	=	790
?	55	"	795	=	735
5th S. S ... pebble and white sand.	56	"	851	=	679

Wet hole. Cased with 3 inch casing at 325′. Pumped 8′ from bottom.

Best production 15 barrels per day. Gas sufficient to fire 1 boiler. Green oil. Gravity 47° to 48°.

The 5th S. S. was close and white with a pebble stratum about 20′ from the top.

This farm produces black oil on its east side, from 40 to 60 rods from this well.

72. *Nell Well.* (189)

August, 1865.

Great Republic Farm, 1 mile south of Shamburg. Authority, Thomas H. Gamble.

Well mouth above ocean in feet					1410
?	40	to	40	=	1370
1st S. S	20	"	60	=	1350
?	190	"	250	=	1160
2d S. S	25	"	275	=	1135
?	195	"	470	=	940
3d S. S	12	"	482	=	928
?	118	"	600	=	810
4th S. S	40	"	640	=	770
?	95	"	735	=	675
5th S. S ... sand, grey.	10	"	745	=	665
? ... pocket.	35	"	780	=	630

Wet hole. Cased at 352′. Pumped 15′ from bottom.

Production ———. Black oil; very little gas.

Digitized by Google

73. *Sassafras Well, No.* 1 (191)

January, 1869.

Beatty Farm, lease No. 48, 1½ miles south-west of Shamburg, at the head of Bull Run, on the upper side of the Titusville and Plumer road. Authority, Phil. Beckman.

Well mouth above ocean in feet					1511
?	400	to	400	=	1111
1st S. S	50	"	450	=	1061
?	128	"	578	=	933
2d S. S	30	"	608	=	903
?	92	"	700	=	811
3d S. S	34	"	734	=	777
?	126	"	860	=	651
4th S. S	14	"	874	=	637
? ... pocket.	6	"	880	=	631

Wet hole. Cased at 604′. Pumped 8′ from bottom.

Black oil. This well was being tested when the record was being given and at that time made a good show of black oil.

74. *Rensselear Oil Company's Well, No.* 10. (246)

February 12, 1867.

On Lot 29; Beatty Farm, Cow Run, property of Clinton Oil Company, 1½ miles south-west of Shamburg. Authority, N. J. Tompkins, Supt.

Well mouth above ocean in feet					1172
Surface sand	25	to	25	=	1147
?	260	"	285	=	887
1st S. S	11	"	296	=	876
?	92	"	388	=	784
2d S. S	25	"	413	=	759
?	105	"	518	=	654
3d S. S ... white sand and pebble.	27	"	545	=	627
? ... pocket.	2	"	547	=	625

Wet hole. Cased at 392′ with 3 inch casing. Gas sufficient to fire 2 boilers

Best production 20 barrels per day. Green oil. Gravity 47°.

This well has been producing over two years and has averaged 16 barrels per day during that time. It is now pumping 10 barrels per day [Feb. 26th, 1869].

75. *Vicker and Russell Well.* (192)

January, 1867.

Patterson Farm, 1 mile east of Pioneer. Authority, ——.

Well mouth above ocean in feet					1403
?	712	to	712	=	691
4th S. S	12	"	724	=	679

Digitized by Google

?	101	to	825	=	578
5th S. S.	25	"	850	=	553

Wet hole. While drilling this well deeper in hopes of finding a sand-bearing green oil, the tools stuck, and the well was abandoned at the depth of 850′.

IV. *Wells along Oil Creek Valley, from Foster's Farm to Oil City.*

---

76. *Sherman Well, No.* 1. (276)

1861.

On Foster Farm, Oil Creek, three-quarters of a mile above Pioneer. Authority, Josephus Chandler.

Well mouth above ocean in feet					1092
?	147	to	147	=	945
1st S. S.	18	"	165	=	927
?	132	"	297	=	795
2d S. S.	15	"	312	=	780
?	118	"	430	=	662
3d S. S. sand and pebble.	36	"	466	=	626
? pocket.	14	"	480	=	612

Wet hole. Seed-bagged on tubing at 300′.

Best production 1200 barrels per day. Green oil. Gravity 45° to 48°.

Gas sufficient to fire 12 boilers.

77. *Porter Well, No.* 1. (231)

1865.

On Foster Farm, on the bank of Oil Creek, above Pioneer. Authority ?

Well mouth above ocean in feet					1096
?	150	to	150	=	946
1st S. S.	8	"	158	=	938
?	150	"	308	=	788
2d S. S.	20	"	328	=	768
?	90	"	418	=	678
3d S. S.	30	"	448	=	648

Wet hole. Seed-bagged on tubing.

Best production 200 barrels per day. Green oil.

This well had a connection with the Grand Trunk Well, about ten rods distant from it. When the water was let into the latter well, by drawing the tubing, this well stopped flowing. But when the tubing was replaced in the Grand Trunk and the pumps started, the Porter Well would again begin to flow.

Digitized by Google

78. *Grand Trunk Well.* (232)

1865.

On Foster Farm flats, above Pioneer. Authority, —— Richards.

Well mouth above ocean in feet					1093
?	150	to	150	=	943
1st S. S	7	"	157	=	936
?	151	"	308	=	785
2d S. S	20	"	328	=	765
?	90	"	418	=	675
3d S. S ....coarse sand and pebble.	30	"	488	=	645

Wet hole. Seed-bagged on tubing at 310′.
Best production 40 barrels per day. Green oil. Gravity 45°.

79. *Foster Well, No.* 61. (228)

January 1863.

On lease No. 61, Foster Farm, Pioneer. Authority, —— Bishop.

Well mouth above ocean in feet					1392
?	624	to	624	=	768
2d S. S	12	"	636	=	756
?	96	"	732	=	660
3d S. S ....white sand and pebble.	38	"	770	=	622
? ....pocket.	5	"	775	=	617

Wet hole. Cased at 630′. Gas sufficient to fire 2 boilers. Best production 30 barrels per day.

80. *Bishop Well.* (229)

1867.

On Foster Farm, near Pioneer. Authority, ———.

Well mouth above ocean in feet					1354
?	20	to	20	=	1334
1st S. S	100	"	120	=	1234
?	436	"	556	=	798
2d S. S	14	"	570	=	784
?	120	"	690	=	664
3d S. S .... slate, sand, and pebble.	35	"	725	=	629
? ....pocket	10	"	735	=	619

Wet hole. Cased at 560′. Half enough gas to fire a boiler.
Best production 4 barrels per day. Green oil. Gravity 49°.

Digitized by Google

81. *Foster Well. Lease* 37. (230)

March, 1867.

On Foster Farm, near Pioneer. Authority, —— Bishop.

Well mouth above ocean in feet					1354
?	562	to	562	=	792
2d S. S	10	"	572	=	782
?	118	"	690	=	664
3d S. S........coarse white sand and pebble.	38½	"	728½	=	625½

Wet hole. Cased at 567′. Gas sufficient to fire one boiler.

Best production 90 barrels per day. Green oil. Gravity 49°.

82. *Well No.* 1, *Lease No.* 2. (240)

July, 1867.

On the Wood Farm, near Petroleum Centre. Authority, J. A. Wharry.

Well mouth above ocean in feet					1475
?	250	to	250	=	12 5
1st S. S	45	"	295	=	1180
?	240	"	535	=	940
2d S. S	50	"	585	=	890
?	130	"	715	=	760
3d S. S	20	"	735	=	740
?	77	"	812	=	663
4th S. S........sand and pebble.	47	"	859	=	616

Wet hole. Cased at 540′. Gas sufficient to fire 16 boilers

Flowing well. Best production 150 barrels per day. Green oil. Gravity 43°.

83. *George K. Anderson Well.* Lease No. 21. (242)

February 14, 1868.

On Wood Farm, near Petroleum Centre. Authority, J. A. Wharry.

Well mouth above ocean in feet					1534
?	615	to	615	=	919
2d S. S	50	"	665	=	869
?	75	"	740	=	794
3d S. S	10	"	750	=	784
?	136	"	886	=	648
4th S. S........pebble.	45	"	931	=	603
?........pocket.	49	"	980	=	554

Wet hole. Cased at 660′. Pumped 55′ feet from bottom.

This well was unproductive. It is situated on the highest hill on the Wood Farm.

Digitized by Google

84. *George K. Anderson Well, Lease No.* 5. (243)

April, 1868.

On Wood Farm, near Petroleum Centre. Authority, J. A. Wharry.

Well mouth above ocean in feet						1487
?		565	to	565	=	922
2d S. S		45	"	610	=	877
?		110	"	720	=	767
3d S. S		8	"	728	=	759
?		107	"	835	=	652
4th S. S	sand and pebble.	45	"	880	=	607
?	pocket	1	"	881	=	606

Wet hole. Cased at ——. Gas sufficient to fire 2 boilers.
Best production 40 barrels per day.

85. *George K. Anderson Well, Lease No.* 33. (245)

February 12, 1868.

On Samuel Wood Farm, near Petroleum Centre. Authority, J. A. Wharry.

Well mouth above ocean in feet						1498
?		570	to	570	=	928
2d S. S		50	"	620	=	878
?		75	"	695	=	803
3d S. S		6	"	701	=	797
?		148	"	844	=	654
4th S. S	sand and pebble.	53	"	897	=	601
?	pocket.	15	"	712	=	586

Wet hole. Cased at 611′. Pumped 17′ feet from bottom. Gas sufficient to fire 2 boilers.
Best production 20 barrels per day. Green oil. Gravity 43°.

86. *Well No.* 1, *Lease* 36. (219)

On Stevenson Farm, at Petroleum Centre. Authority, Geo. K. Anderson.

Well mouth above ocean in feet						1368
?		457	to	457	=	911
1st S. S		13	"	470	=	898
?		105	"	575	=	793
2d S. S		2	"	577	=	791
?		140	"	717	=	651
3d S. S		45	"	762	=	606
?	pocket.	10	"	772	=	596

Digitized by Google

87. *Well No* 1, *Lease* 51. (220)

On Stevenson Farm, at Petroleum Centre. Authority, Geo. K. Anderson.

Well mouth above ocean in feet					1350
?	428	to	428	=	922
1st S. S	6	"	434	=	916
?	145	"	579	=	771
2d S. S	30	"	609	=	741
?	83	"	692	=	658
3d S. S	46	"	738	=	612

88. *Pinner Well.* (221)

February, 1867.

On Robert Stevenson's Farm, about one mile north of Petroleum Centre. Authority, ———.

Well mouth above ocean in feet					1369
?	200	to	200	=	1169
1st S. S	40	"	240	=	1129
?	200	"	440	=	929
2d S. S	15	"	455	=	914
?	256	"	711	=	658
3d S. S. sand and pebble.	40	"	751	=	618
? pocket.	14	"	765	=	604

Wet hole. Cased at 450′.

Best production 25 barrels per day. Green oil. Gravity 47°. Gas sufficient to fire 2 boilers.

This well is one of those that need some appliance to draw the gas from the well. We are now [Feb. 12, 1869] using a rotary pump, which not only increases the amount of gas, but helps the production. This well is producing as well as it was two years ago (in 1867).

89. *Well No.* 1, *Lease* 134. (213)

On Central Petroleum Co.'s land at Petroleum Centre. Authority, Geo. K. Anderson.

Well mouth above ocean in feet					1106
?	193	to	193	=	913
1st S. S	47	"	240	=	866
?	105	"	345	=	761
2d S. S	7	"	352	=	754
?	123	"	475	=	631
3d S. S	39	"	514	=	592
? pocket.	52	"	566	=	540

Digitized by Google

90. *Well No.* 1, *Lease* 305. (214)

On Central Petroleum Co.'s land at Petroleum Centre. Authority, Geo. K. Anderson.

Well mouth above ocean in feet					1257
?	340	to	340	=	917
1st S. S	50	"	390	=	867
?	103	"	493	=	764
2d S. S	7	"	500	=	757
?	110	"	610	=	647
3d S. S	48	"	658	=	599
? ... pocket.	20	"	678	=	579

91. *Well No.* 1, *Lease* 306. (215)

On Central Petroleum Co.'s land at Petroleum Centre. Authority, Geo K. Anderson.

Well mouth above ocean in feet					1234
?	316	to	316	=	918
1st S. S	48	"	364	=	870
?	108	"	472	=	762
2d S. S	7	"	479	=	755
?	111	"	590	=	644
3d S. S	46	"	636	=	598
? ... pocket.	12	"	648	=	586

92. *Well No.* 1, *Lease* 37. (217)

On Stevenson Farm, at Petroleum Centre. Authority, Geo. K. Anderson.

Well mouth above ocean in feet					1372
?	459	to	459	=	913
1st S. S	13	"	472	=	900
?	105	"	577	=	795
2d S. S	2	"	579	=	793
?	140	"	719	=	653
3d S. S	45	"	764	=	608
? ... pocket	29	"	793	=	579

93. *Swamp Angel* Well, No.* 3. (247)

On lease No. 141, Central Petroleum Co.'s land at Petroleum Centre. Authority, Geo. K. Anderson.

Well mouth above ocean in feet					1092
?	185	to	185	=	907
1st. S. S	15	"	200	=	892

*It would puzzle an antiquary of the next century to explain this name; but as it was taken from the army sobriquet of the huge piece of ordnance used before Fort Sumter, the name of the well enables us to assign as its probable date 1861.

Digitized by Google

?	133	to	333	=	759
2d S. S	6	"	339	=	753
?	121	"	460	=	632
3d S. S	43	"	503	=	589
? ... pocket.	45	"	548	=	544

94. *Swamp Angel Well, No.* 4. (248)

On lease No. 141, Central Petroleum Co.'s land at Petroleum Centre. Authority, Geo. K. Anderson.

Well mouth above ocean in feet					1094
?	160	to	160	=	934
1st S. S	40	"	200	=	894
?	140	"	340	=	754
2d S. S	6	"	346	=	748
?	119	"	465	=	629
3d S. S	45	"	510	=	584
	42	"	552	=	542

95. *Abbe and Bailey Well.* (283)

1866.

On lease 156, Central Petroleum Co.'s land at Petroleum Centre. Authority ———.

Well mouth above ocean in feet					1093
?	190	to	190	=	903
1st S. S	42	"	232	=	861
?	108	"	340	=	753
2d S. S	20	"	360	=	733
?	103	"	463	=	630
3d S. S	40	"	503	=	590

Wet hole. Seed-bag at 350′.
Gas sufficient to fire 1 boiler. Mud vein at 340′.
Best production 15 barrels per day.

96. *Abbe and Bailey Well.* (285)

1865.

On lease 179, Central Petroleum Co.'s land at Petroleum Centre. Authority, ———.

Well mouth above ocean level					1093
?	185	to	185	=	908
1st S. S	45	"	230	=	863
?	110	"	340	=	753
2d S. S	20	"	360	=	733
?	105	"	465	=	628
3d S. S ... sand and pebble.	40	"	505	=	588
? ... pocket.	28	"	533	=	560

Wet hole. Cased at 350′. Gas sufficient to fire 1 boiler. Mud vein at 464′.

Best production 75 barrels per day. Green oil. Gravity 46°.

Digitized by Google

97. *Mary Ann Well.* (223)

April, 1868.

On lease No. 24, Bennehoff Farm, on the bluff between Petroleum Centre and Pioneer. Authority, Edward E. Partridge.

Well mouth above ocean in feet					1397
?	473	to	473	=	924
1st S. S	11	"	484	=	913
?	139	"	623	=	774
2d S. S	12	"	635	=	762
?	104	"	739	=	658
3d S. S ... pebble and sand.	41	"	780	=	617

Wet hole. Cased at 624′. Pumped 4 feet from bottom. Mud vein on top of 3d S. S. Best production 120 barrels per day. Green oil. Gravity 46°. Gas sufficient to fire 1 boiler. Blower attached as soon as the water was exhausted.

There is a surface sand about 60 feet from the top, and a mountain sand about 100 feet below the surface sand, about 65 feet thick. I believe that wells on the flat do not find either of the above sands. On the hill, we call the sands, first, second, and third sands. Some seed-bag in the 1st sand. I think that the majority of the wells on this farm are seed-bagged in the first sand.

98 *Harding and Jones Well.* (225)

February 7, 1869.

On lease No. 9, Bennehoff Farm, on the bluff between Petroleum Centre and Pioneer. Authority, N. Jones.

Well mouth above ocean in feet					1445
?	300	to	300	=	1145
1st S. S	30	"	330	=	1115
?	185	"	515	=	930
2d S. S	10	"	525	=	920
?	100	"	625	=	820
3d S. S	20	"	645	=	800
?	133	"	778	=	667
4th S. S ... sand and pebble.	49	"	827	=	618
? ... pocket.	8	"	835	=	610

Wet hole. Cased at 520′. Pumped 6 feet from the bottom. Mud vein at 820′. Gas sufficient to fire one boiler.

Best production 50 barrels per day. Green oil. Gravity 47°.

Digitized by Google

99 *Courts and Andrews Well.* (226)

July 30, 1869.

On lease No. 8, Bennehoff Farm, on the bluff between Petroleum Centre and Pioneer. Authority, T. I. Thompson, Agent.

Well mouth above ocean in feet					1435
?	60	to	60	=	1375
1st S. S	30	"	90	=	1345
?	412	"	502	=	933
2d S. S	10	"	512	=	923
?	125	"	637	=	798
3d S. S	8	"	645	=	790
?	124	"	769	=	666
4th S. S ... pebble.	43	"	812	=	623

Wet hole. Cased at 504′. Pumped 4′ from bottom. Mud vein at 808′. Gas sufficient to fire 2 boilers.

Best production 180 barrels per day. Green oil. Gravity 48°.

100. *Stuart Well.* (227)

September 1868.

On lease No. 7, Bennehoff Farm, on the bluff between Petroleum Centre and Pioneer. Authority, John Waddell.

Well mouth above ocean in feet					1405
?	60	to	60	=	1345
1st S. S	70	"	130	=	1275
?	420	"	550	=	855
2d S. S	20	"	570	=	835
?	48	"	618	=	787
3d S. S	14	"	632	=	773
?	108	"	740	=	665
4th S. S ... sand and pebble.	40	"	780	=	625
? ... pocket.	2	"	782	=	623

Wet hole. Cased at 554′. Pumped 4′ from bottom. Mud vein at 744′. Best production 14 barrels per day. Green oil. Gravity 44°.

101. *Blocker Well.* (249)

June, 1868.

Columbia Oil Company's "Story Farm," Oil Creek. Authority, George Boulton, Supt.

Well mouth above ocean in feet					1120
?	240	to	240	=	880
1st S. S	20	"	260	=	860
?	115	"	375	=	745
2d S. S	31	"	406	=	714

Digitized by Google

?		113	to	519	=	601
3d S. S.	pebble and sand.	52	"	571	=	549
?	pocket.	1	"	572	=	548

Wet Hole. Cased at 500′. Pumped 8′ from bottom.

Best production 175 barrels per day. Gas sufficient to fire 1 boiler. Green oil. Gravity 47°. No mud veins.

102. *Babcock Well.* (250)

July, 1866.

Columbia Oil Company's "Story Farm," Oil Creek. Authority, George Boulton, Supt.

Well mouth above ocean in feet						1223
?		345	to	345	=	878
1st S. S.		41	"	386	=	837
?		89	"	475	=	748
2d S. S.		25	"	500	=	723
?		95	"	595	=	628
3d S. S.	pebble and sand.	47	"	642	=	581
?	pocket.	5	"	647	=	576

Wet hole. Not cased. Seed bag at 485′. Pumped 10′ from bottom.

Best production 165 barrels per day. Gas sufficient to fire 3 boilers. Green oil. Gravity 47°. Mud vein at 598′.

03. *Goe Well.* (251)

——— ——— ———.

Columbia Oil Company's "Story Farm," Oil Creek. Authority, George Boulton, Supt.

Well mouth above ocean in feet						1256
?		380	to	380	=	876
1st S. S.		32	"	412	=	844
?		108	"	520	=	736
2d S. S.		27	"	547	=	709
?		98	"	645	=	611
3d S. S.	pebble and sand.	42	"	687	=	569
?	pocket.	6	"	693	=	563

Wet hole. Not cased. Seed bag at 530′. Pumped 12′ from bottom.

Best production 120 barrels per day. Gas sufficient to fire one boiler Green oil. Gravity 47°. Mud vein at 647′.

Digitized by Google

104. *Reiter Well.* (252)

Columbia Oil Company's "Story Farm," Oil Creek. Authority, George Boulton, Supt.

Well mouth above ocean in feet					1291
?	420	to	420	=	871
1st S. S	35	"	455	=	836
?	100	"	555	=	736
2d S. S	24	"	579	=	712
?	94	"	673	=	618
3d S. S. .....pebble and sand.	44	"	717	=	574
? .....pocket.	5	"	722	=	569

Wet hole. Cased at 565′. Pumped 8′ from bottom.

Best production 55 barrels per day. Gas sufficient to fire 5 boilers. Green oil. Gravity 47°. Mud vein at 676′.

105. *Boulton Well.* (253)

October, 1868.

Columbia Oil Company's "Story Farm," Oil Creek. Authority, George Boulton, Supt.

Well mouth above ocean in feet					1374
?	462	to	462	=	912
1st S. S	40	"	502	=	872
?	98	"	600	=	774
2d S. S	20	"	620	=	754
?	122	"	742	=	632
3d S. S. .....pebble and sand.	47	"	789	=	585
? .....pocket.	5	"	794	=	580

Wet hole. Cased at 470′. Pumped 8′ from bottom.

Best production 12 barrels per day. Gas sufficient to fire one boiler. Green oil. Gravity 47°. No mud vein.

106. *Story Centre Well, No.* 1. (284)

July, 1863.

On lease No. 27, Columbia Oil Co.'s Story Farm, Oil Creek. Authority, George Boulton, Supt.

Well mouth above ocean in feet					1065
?	200	to	200	=	865
1st S. S	40′	"	240	=	825
?	90	"	330	=	735
2d S. S	31′	"	361	=	704
?	104	"	465	=	600
3d S S. .....sand and pebble.	47′	"	512	=	553

Wet hole. Seed bagged on tubing at 330′. Pumped 10′ from bottom. Gas sufficient to fire 3 boilers.

Best production 250 barrels per day. Green Oil. Gravity 46°.

Digitized by Google

107. *Phillips Well, No.* 2. (255)

1861.

Tarr Farm, Oil Creek, 2 miles above Rouseville. Authority, ———.

Well mouth above ocean in feet					1057
?	10	to	10	=	1047
Mountain sand	70	"	80	=	977
?	100	"	180	=	877
1st S. S.	30	"	210	=	847
?	111	"	321	=	736
2d S. S.	27	"	348	=	709
?	77	"	425	=	632
Sandy shell	2	"	427	=	630
Slate	4	"	431	=	626
"Gray rock"	40	"	471	=	586
3d S. S. not through	10	"	481	=	576

Best production 3,940 barrels per day, by actual measurement. Green oil. Gravity 46°. Mud vein at 466′. Size of hole 4 inches. Tubed with 2¼ in. tubing without a working barrel.

This well has produced over 600,000 barrels of oil to present date (March 1, 1869), which has been sold at from 10 cents to $14.50 per barrel at the well.

It started to flow before drilling was completed and threw out the water and oil so furiously that the tubing could not be put in to shut off the water for three days, and even then the tubing had to be chained down to keep it from being blown out of the hole.

The well was lately searched by "Dale's crevice searcher," which reported a crevice of 3 inches at the depth of 472$\frac{7}{12}$ feet.

108. *Union Well.* (254)

1862.

Tarr Farm, Oil Creek. Authority, ———.

Well mouth above ocean in feet					1066
?	195	to	195	=	871
1st S. S.	30	"	225	=	841
?	100	"	325	=	741
2d S. S.	25	"	350	=	716
?	130	"	480	=	586
3d S. S. ......pebble and sand.	30	"	510	=	556

Wet hole. Not cased.

Best production 200 barrels per day. Green oil. Gravity 47°.

Digitized by Google

109. *Lynn Well, No.* 2. (256)

November, 1867.

Lease No. 192, Tarr Farm, Oil Creek. Authority, J. H. Dilks.

Well mouth above ocean in feet					1231
?	100	to	100	=	1131
1st S. S	80	"	180	=	1051
?	240	"	420	=	811
2d S. S	20	"	440	=	791
?	90	"	530	=	701
3d S. S	32	"	562	=	669
?	75	"	637	=	594
4th S. S........pebble and sand.	42	"	679	=	552

Wet hole. Cased at 607′. Pumped 7′ from bottom.

Best production 60 barrels per day. Gas sufficient to fire 3 boilers. Green oil. Gravity 47°.

This well was torpedoed at 649′ and 664′. The production before was 15 barrels, afterwards 40 barrels.

110. *Sterling Well.* (275)

1861–5.

On Tar Farm, Oil Creek above Rouseville. Authority, Ambrose John Moran.

Well mouth above ocean in feet					1052
?	195	to	195	=	857
1st S. S	30	"	225	=	827
?	85	"	310	=	742
2d S. S	30	"	340	=	712
?	120	"	460	=	592
3d S. S........sand and pebble.	35	"	495	=	557

Wet hole. Cased at 320′. Pumped 1′ from bottom.

Best production 200 barrels per day. Green oil. Gravity 44°. Gas sufficient to fire 3 boilers. Mud vein at 465′.

111. *Byron Mitchell Well, No.* 1. (257)

November, 1868.

Lease No. 258, Blood Farm, Oil Creek, 1½ miles north of Rouseville. Authority, S. Hyland.

Well mouth above ocean in feet					1309
?	685	to	685	=	624
2d S. S	29	"	714	=	595
?	1	"	715	=	594

Digitized by Google

3d S. S........................pebble and sand.	40	to	755	=	554
?..................................pocket.	3	"	758	=	551

Wet hole. Cased at 685′.

Best production 120 barrels per day. Gas sufficient to fire 1 boiler. Green Oil. Gravity 44°.

This well was doing 20 barrels when a torpedo was exploded in it, which had a damaging effect, reducing the production to 8 barrels.

112. *Lady Suffolk Well.* (258)

June, 1868.

Lease No. 240, Blood Farm, Oil Creek, 1½ miles north of Rouseville. Authority, A. B. Mudge.

Well mouth above ocean in feet					1334
?	465	to	465	=	869
1st S. S	40	"	505	=	829
?	105	"	610	=	724
2d S. S	26	"	636	=	698
?	61	"	697	=	637
3d S. S ...."gray rock."	25	"	722	=	612
?	24	"	746	=	588
4th S. S......................pebble and sand.	37	"	783	=	551

Wet hole. Cased at 706′. Pumped 7′ from bottom.

Best production 85 barrels per day. Gas sufficient to fire 2 boilers. Green oil. Gravity 45°.

113. *Ætna Well.* (259)

——— ——— ———.

Lease No. 18, Rynd Farm, Oil Creek, 1 mile north of Rouseville. Authority, George K. Anderson.

Well mouth above ocean in feet					1043
?	190	to	190	=	853
1st S. S	28	"	218	=	825
?	114	"	332	=	711
2d S. S	18	"	350	=	693
?	115	"	465	=	578
3d S. S	32	"	497	=	546
?..................................pocket.	14	"	511	=	532

114. *Pacific Well, No.* 1. (260)

January, 1863.

Lease No. 17, Rynd Farm, Oil Creek, 1 mile north of Rouseville. Authority, Hendrickson and Walker.

Well mouth above ocean in feet					1045
?	195	to	195	=	850

Digitized by Google

1st S. S.	25	to	220	=	825
?	115	"	335	=	710
2d S. S.	28	"	363	=	682
?	110	"	473	=	572
3d S. S.	35	"	508	=	537
?...pocket.	7	"	515	=	530

Wet hole. Not cased. Seed-bag at 460′.

Best production 12 barrels per day. Gas sufficient to fire 1 boiler. Green oil. Gravity 45°.

On the Blood and Rynd Farms there is a gray S. S. lying immediately over the third rock. Most operators think that this gray sand is an oil producing rock.

115. *Well No.* 23. (261)

August, 1867.

Rynd Farm, Oil Creek, 1 mile north of Rouseville. Authority, Supt. of of Rynd Farm.

Well mouth above ocean in feet					1043
?	188	to	188	=	855
1st S. S.	23	"	211	=	832
?	117	"	328	=	715
2d S. S.	26	"	354	=	689
?	121	"	475	=	568
3d S. S....pebble and sand.	28	"	503	=	540
?...pocket.	10	"	513	=	530

Wet hole. Not cased. Seed-bag at 190′.

Best production 10 barrels per day. Green oil. Gravity 46°.

There never was an instance on this farm of one well interfering with another. All the wells producing to-day are pumping oil only. No advantage is gained in the amount of gas by the use of casing, and casing is not much used on the farm. [March 2d, 1869].

116. *Keir Well, No.* 1. (262)

1862.

Rynd Farm, Oil Creek, 1 mile north of Rouseville. Authority, ———.

Well mouth above ocean in feet					1040
?	191	to	191	=	849
1st S. S.	23	"	214	=	826
?	117	"	331	=	709
2d S. S.	26	"	357	=	683
?	121	"	478	=	562
3d S. S....pebble and sand.	30	"	508	=	532

Wet hole.

Best production 250 barrels per day. Green oil. Gravity 45°.

This well flowed while being drilled, from the 2d rock, or at 357′. We

Digitized by Google

tubed in this sand and the well yielded 250 barrels per day for some time, but we spoiled it by shutting off the flow by a stop cock; well was afterwards put deeper, but no increase of oil.

117. *Emory Well, No* 1. (263)

January, 1865.

A. Buchanan Farm, on Cherry Run, ½ mile above Rouseville. Authority, A. A. Emory.

Well mouth above ocean in feet					1056
?	212	to	212	=	844
1st S. S	37	"	249	=	807
?	106	"	355	=	701
2d S. S	30	"	385	=	671
?	111	"	496	=	560
3d S. S ... pebble and sand.	34	"	530	=	526
? ... pocket.	13	"	543	=	513

Wet hole. Not cased. Seed-bag at 360′.

Best production 28 barrels per day. Half enough gas to fire a boiler. Green oil. Gravity 43°. Mud vein at 516′.

Very near this well a well was put down which had to be abandoned while drilling in the 2d S. S., but it was pumped for an experiment and produced 900 barrels of dark oil.

118. *Well No*. 13. (264)

December, 1866.

Farm of Union Petroleum Co. of New York, Cherry Run, ¾ of a mile above Rouseville. Authority, E. W. Hinds, Supt.

Well mouth above ocean in feet					1086
?	221	to	221	=	865
1st S. S	67	"	288	=	798
?	86	"	374	=	712
2d S. S	26	"	400	=	686
?	120	"	520	=	566
3d S. S ... pebble and sand.	31	"	551	=	535

Wet hole. Not cased. Seed-bag at 380′.

Green oil. Gravity 46°. The well is now averaging 3 barrels per day [March 3, 1869].

119. *Well No*. 6. (265)

——— ——— ———.

Farm of Union Petroleum Co. of New York, Cherry Run, ¾ of a mile above Rouseville. Authority, E. W. Hinds, Supt.

Digitized by Google

Well mouth above ocean in feet					1086
?	218	to	218	=	868
1st S. S	67	"	285	=	801
?	85	"	370	=	716
2d S. S	32	"	402	=	684
?	118	"	520	=	566
3d S. S ... pebble and sand.	41	"	561	=	525
? ... pocket.	29	"	590	=	496

Wet hole. Not cased. Seed bag at 375′.
Green oil. Gravity 46°.

120. *Munson Well.* (267)

October, 1866.

Lease No. 1, Curtin Oil Co.'s tract, on Cherry Run, 1 mile above Rouseville. Authority, ———.

Well mouth above ocean in feet					1103
?	240	to	240	=	863
1st S. S	32	"	272	=	831
?	108	"	380	=	723
2d S. S	28	"	408	=	695
?	132	"	540	=	563
3d S. S ... pebble and sand.	34	"	574	=	529
? ... pocket.	20	"	594	=	509

Wet hole. Not cased. Seed bag at 410′. Pumped 30′ from bottom.

Best production 120 barrels per day. Gas sufficient to fire 1 boiler. Green oil. Gravity 46°.

This well is near the celebrated Reed Well, and one record will answer for both.

121. *Champion Well, No.* 2. (268)

February, 1868.

Buchanan Farm, Rouseville. Authority, Superintendent of Rouseville Oil Co.

Well mouth above ocean in feet					1047
?	200	to	200	=	847
1st S. S	33	"	233	=	814
?	117	"	350	=	697
2d S. S	25	"	375	=	672
?	115	"	490	=	557
3d S. S	15	"	505	=	542
? ... pocket.	15	"	520	=	527

Wet hole. Not cased. Seed bag at 360′.

Best production 100 barrels per day. Gas sufficient to fire 2 boilers.

This well only produced for two days; stopped short off. Think it

Digitized by Google

pumped what oil it did from the 2d sand. Think it best not to drill through the 3d sand, less likely to get salt water.

122. *Elizabeth Well.* (269)

1862.

Clapp Farm, Oil Creek, between Rouseville and Oil City. Authority ?

Well mouth above ocean in feet					1005
?	200	to	200	=	805
1st S. S	20	"	220	=	785
?	140	"	360	=	645
2d S. S	15	"	375	=	630
?	85	"	460	=	545
3d S. S	30	"	490	=	515
? pocket.	110	"	600	=	405

Wet hole. Cased at 373′.

Best production 100 barrels per day. Green oil.

The well is now being pumped from the 2d S. S.; in pumping a large amount of water with a little oil, perhaps 6 barrels on an average [March 4, 1869].

V. *Wells along the Allegheny River from Oil City to West Hickory.*

---

123. *Siverly and Gardner Well.* (270)

1866.

Lease No. 11, Siverly Farm, Allegheny River $1\frac{1}{4}$ miles above Oil City. Authority, J. W. Gardner, Supt.

Well mouth above ocean in feet					1012
?	260	to	260	=	752
1st S. S	20	"	280	=	732
?	110	"	390	=	622
2d S. S	20	"	410	=	602
?	80	"	490	=	522
3d S. S pebble and sand.	31	"	521	=	491
? pocket.	19	"	540	=	472

Wet hole. Cased at 400′.

Best production —. Half enough gas to fire a boiler. Green oil. Gravity 46°.

This well is a fair type of 15 wells on the Siverly farm, which altogether produced 40 barrels per day. They are pumped by heads.

Digitized by Google

124. *Lowell Well.* (271)

March, 1867.

Howard Oil Association lease, Alcorn Farm, Allegheny River, 3 miles above Oil City. Authority, L. Lowell.

Well mouth above ocean in feet					1016
?	278	to	278	=	738
1st S. S	8	"	286	=	730
?	70	"	356	=	660
2d S. S	9	"	365	=	651
?	29	"	394	=	622
3d S. S	21	"	415	=	601
?	81	"	496	=	520
4th S. S. ...shelly.	34	"	530	=	486
? ...pocket.	20	"	550	=	466

Wet hole. Cased at 100′.

Best production 6 barrels per day. Half enough gas to fire a boiler. Green oil. Gravity 42°.

The wells on the river in this locality do not afford much gas.

Torpedoes have been tried in some wells above Oil City with no advantage.

125. *Vandergrift Well, No.* 1. (272)

August, 1868.

On 10 acre tract, by H. McClintock Farm, on Allegheny River, about 3 miles below Oleopolis. Authority, J. J. Vandergrift.

Well mouth above ocean in feet					1039
?	197	to	197	=	842
1st S. S	20	"	217	=	822
?	74	"	291	=	748
2d S. S	30	"	321	=	718
?	20	"	341	=	698
3d S. S. ...pebble.	18	"	359	=	680
? ...pocket.	11	"	370	=	669

Wet hole. Seed-bagged on tubing at 120′.

Best production 1 barrel per day. Green oil. Gravity 40°. Half enough gas to fire a boiler.

This well is in the vicinity of a number of wells, all of which are pumping oil from the 2d sand. The oil is of lighter color, but heavier gravity, than the Oil Creek oil. Some of these wells have been pumping for six years [March 5, 1869].

126. *Madden Well.* (273)

1865.

On Anderson Petroleum Co.'s Farm, Allegheny River, ½ mile below the mouth of Pithole Creek. Authority, ———.

Well mouth above ocean in feet ... 1032

Digitized by Google

?..	160	to	160	=	872
1st S. S..	44	"	204	=	828
?..	83	"	287	=	745
2d S. S....................sand and pebble.	18	"	305	=	727
?..................................pocket.	4	"	309	=	723

Wet hole. Seed-bag at 170′.

Best production 60 barrels per day. Amber oil. Gravity 42°.

It is said that the 3d sand has not been found in this locality, though wells have been drilled 600′ and 800′ deep.

127. *Smith and Schribel Well.* (299)

June, 1869.

Hussey and McBride Farm, Henry's Bend, Allegheny River. Authority, ———.

Well mouth above ocean in feet..................................					1027
?..	149	to	149	=	878
1st S. S..	22	"	171	=	856
?..	62	"	233	=	794
2d S. S..	10	"	243	=	784
Red slate..	11	"	254	=	773
3d S. S..	12	"	266	=	761
?.................................pocket.	3	"	269	=	758

Wet hole. Cased at 150′.

Best production 8 barrels per day. Amber oil. Gravity 42°.

Another well on the side hill 109′ above this well went through 3d S. S. at 375′. This well is about 10′ above surface of river.

128 *Hunter, Hebert and Carll Well.* (306)

1869.

Hunter Run, ½ mile from Allegheny River, opposite Tionesta, Forest Co. Authority, John F. Carll.

Well mouth above ocean in feet..................................					1092
?..	160	to	160	=	932
1st S. S..	8	"	168	=	924
?..	90	"	258	=	834
2d S. S..	8	"	266	=	826
?..	15	"	281	=	811
3d S. S..	10	"	291	=	801
?..	15	"	306	=	786
4th S. S.............coarse pebble in red mud.	15	"	321	=	771
?..	116	"	437	=	655

Wet hole. Some oil and gas.

Digitized by Google

129. *Hamilton Well.* (200)

September, 1869.

Hickory Farm Oil Co., Allegheny River at the mouth of West Hickory Creek, Forest Co. Authority, ———.

Well mouth above ocean in feet					1100
?	100	to	109	=	1000
1st S. S	25	"	125	=	975
?	35	"	160	=	940
2d S. S ....not through.	6½	"	166½	=	933½

Wet hole. Not cased. Seed-bag at 104′.

Best production 60 barrels per day. Green oil. Gravity 33°.

This well, like most others on this and adjoining farms, pumps a large amount of water, which is supposed to come into the well with the oil. November 5, 1869, it was pumping 6 to 10 barrels of heavy oil with 100 to 200 barrels of water.

VI. *Wells at Enterprise in Warren County.*

---

130. *Benedict Estate Well, No.* 1. (167)

Summer of 1865.

Benedict Estate Farm, Enterprise, Warren Co. Authority, ———.

Well mouth above ocean in feet					1235
?	192	to	192	=	1043
1st S. S	50	"	242	=	993
?	58	"	300	=	935
2d S. S	6	"	306	=	929
?	29	"	335	=	900
3d S. S	10	"	345	=	890
?	97	"	442	=	793
4th S. S	6	"	448	=	787
?	14	"	462	=	773
5th S. S ....pebble.	15	"	477	=	758
? ....pocket.	10	"	487	=	748

Wet hole. Cased at 342′. Pumped 10′ from bottom.

Best production 8 barrels per day. Half enough gas to fire 1 boiler. Green oil. Gravity 47°.

131. *McKinney Well, No.* 1. (170)

March, 1869.

Lease No. 9, Benedict Estate Farm, Enterprise, Warren County. Authority, C. B. McKinney.

Well mouth above ocean in feet	1222

Digitized by Google

? ....estimated.	183	to	183	=	1039
1st S. S.	50	"	233	=	989
?	79	"	312	=	910
2d S. S.	10	"	322	=	900
?	88	"	410	=	812
3d S. S.	20	"	430	=	792
?	10	"	440	=	782
4th S. S. ....pebble.	16	"	456	=	766
? ....pocket.	18	"	474	=	748

Wet hole. Cased at 338′.

Best production 180 barrels per day. Gas sufficient to fire 2 boilers. Green oil. Gravity 45°.

The 4th S. S. is the oil bearing rock. The 2d S. S. contains large veins of salt water. The well has been run one month and is as good as ever on an average.

132. *McKinney Well, No.* 2. (171)

August, 1868.

Lease 17, Benedict Estate, Enterprise, Warren County. Authority, C. B. McKinney.

Well mouth above ocean in feet.................................... 1225

? ....estimated.	196	to	196	=	1029
1st S. S.	60	"	256	=	969
?	58	"	314	=	911
2d S. S. ....pebble.	14	"	328	=	897
?	86	"	414	=	811
3d S. S.	20	"	434	=	791
?	10	"	444	=	781
4th S. S. ....pebble.	21	"	465	=	760
? ....pocket.	17	"	482	=	743

Wet hole. Cased at 335′. Pumped 6′ from bottom.

Best production 30 barrels per day. Gas sufficient to fire one boiler. Green oil. Gravity 45°.

A torpedo improves the well. 2d S. S. contains salt water. 4th S. S. is oil producing.

VII. *Wells at Church Run and in its Vicinity, in Crawford County.*

---

133. *Eureka Well.* (202)

November 1865.

On land of Atlantic and Great Western Petroleum Co., on Church Run, one and a-half miles north-east of Titusville, Crawford County. Authority, H. S. Rogers, Superintendent.

Well mouth above ocean in feet.................................... 1327

Digitized by Google

?	230	to	230	=	1097
1st S. S	67	"	297	=	1030
?	174	"	471	=	856
2d S. S	15	"	486	=	841
?	18	"	504	=	823
3d S. S .... very coarse with pebbles.	70	"	574	=	753
? .... pocket.	10	"	584	=	743

Wet hole. Cased at 350′. Pumped 15′ from bottom.

Best production 175 barrels per day. Gas sufficient to fire 3 boilers. Green oil. Mud veins are found in some of the wells on the higher ground, but were rare in the Eureka well.

This well from the long time that it has been pumping can be considered to be one of the most remarkable in this region, having been one of the first drilled on Church Run. It now averages 140 barrels per week [February, 1869].

When first started it produced about 52 barrels per day. It gradually ran down until in May (1868), it was producing about 25 barrels per week.

It was then cleaned out, casing and seed-bag being drawn, and torpedoed in the middle of the third sand. Casing was then put in, and it was started up, and for some days produced 175 barrels per day. Referring to the books, I find that in one week it pumped 910 barrels of the best, clear Church Run oil.

We find that a torpedo, every six weeks, is required to be exploded in the middle of the third sand, to open up and clean the rock. There is still sufficient gas to run the engine [February, 1869].

The company are now pumping their eleventh well. Out of this number but two have proved failures.

134. *Niagara Well, No.* 1. (201)

May, 1867.

On three acre tract, formerly Cadwallader and Morse at Church Run, Crawford Co. Authority, ———.

Well mouth above ocean in feet					1312
?	218	to	218	=	1094
1st S. S	40	"	258	=	1054
?	200	"	458	=	854
2d S. S	15	"	473	=	839
?	16	"	489	=	823
3d S. S .... pebble and sand.	65	"	554	=	758
? .... pocket.	9	"	563	=	749

Wet hole. Cased at 300′. Pumped 13′ from bottom.

Best production 25 barrels per day. Gas sufficient to fire 1 boiler. Green oil. Gravity 45°.

Digitized by Google

135. "*Ike*" *Weed Well.* (204)

January, 1867.

On tract of Williams, Severance and Co., on Church Run, one and a quarter mile north-east of Titusville, Crawford Co. Authority, L. H. Severance, Treas.

Well mouth above ocean in feet					1394
?	298	to	298	=	1096
1st S. S	30	"	328	=	1066
?	209	"	537	=	857
2d S. S	15	"	552	=	842
?	19	"	571	=	823
3d S. S ....pebble.	66	"	637	=	757
? ....pocket.	9	"	646	=	748

Wet hole. Cased at 400′. Pumped 35′ from bottom.

Best production 15 barrels per day. Oil green. Gravity 47°. Gas sufficient to fire 1 boiler.

Well is now [February 12th, 1869] pumping on an average 6 barrels per day. Are only running it in the day, making but 12 hours pumping. With torpedoes, has pumped 10 barrels per day.

136. *Humphrey Well, No.* 2. (205)

December, 1868.

On Atlantic and Great Western Petroleum Co.'s tract on Church Run, one and one-half miles north-east of Titusville, Crawford Co. Authority, —.

Well mouth above ocean in feet					1425
?	330	to	330	=	1095
1st S. S.	60	"	390	=	1035
?	175	"	565	=	860
2d S. S	25	"	590	=	835
?	20	"	610	=	815
3d S. S ....sand and pebble.	62	"	672	=	753
? ....pocket.	3	"	675	=	750

Wet hole. Cased at 404′. Pumped 14′ from bottom.

Best production, 300 barrels per day. Green oil. Gravity 45°. Gas sufficient to fire 3 boilers.

This well is now [February 9th, 1839].pumping 65 barrels per day.

137. *Yreka Well, No.* 1. (206)

August, 1868.

On the Weed Farm. Church Run, 1¼ miles north-east of Titusville, Crawford Co. Authority, Chester Morse.

Well mouth above ocean in feet					1454
?	365	to	365	=	1089

Digitized by Google

1st S. S	63	to	428	=	1026
? including 2d S. S	212	"	640	=	814
3d S. S. ... sand and pebble.	60	"	700	=	754

Wet hole. Cased at 365′.

Best production 70 barrels per day. Gas sufficient to fire 2½ boilers. Green oil. Gravity 45°.

138. *King Well.* (211)

1864.

On Watson Flats, ½ mile south of Titusville, Crawford Co. Authority,——.

Well mouth above ocean in feet					1168
?	170	to	170	=	998
1st S. S	20	"	190	=	978
?	190	"	380	=	788
2d S. S	35′	"	415	=	753

Wet hole. Cased at 180′. Pumped 10′ from bottom.

Best production 10 barrels per day. Green oil. Gravity 44°. One half enough gas to fire a boiler.

This well has been pumped nearly all the time since it was struck, while in the immediate vicinity many have been abandoned and left without any seed-bag. It is the opinion of many, that if three-fourths of the holes on the flat were seed-bagged the other fourth would be paying wells at the present time [about Jan., 1869].

VIII. *Miscellaneous Wells.*

139. *Major Well.* (279)

Summer of 1867.

On Major Farm, section 1618, Sparta Township, 2½ miles S. E. of Spartansburg, Crawford Co. Authority, Wm. Johns.

Well mouth above ocean in feet					1600
?	205	to	205	=	1395
1st S. S	15	"	220	=	1380
?	240	"	460	=	1140
2d S. S. ... white, coarse.	25	"	485	=	1115
?	260	"	745	=	855

Wet hole. Seed-bagged on tubing at 210′. Gas sufficient to fire 15 boilers. No oil

This well was tested by pumping it for one day, when it gave signs of flowing. The second day the rods and valves were drawn, when it commenced flowing gas and water at the rate of about 100 barrels per day, and continued thus for six months. The tubing was then drawn to explode a

Digitized by Google

torpedo. It was afterwards tubed, and flowed water for 9 months, when the seed-bag burst. Since then nothing has been done to it. At one time the water flowed outside of the tubing, and was thrown 15 feet high.

140. *Well No.* 175. (301)

Triumph Oil Company, Triumph, Warren Co., 2 miles south-west of Tidioute. Authority, Superintendent of Farm.

Well mouth above ocean in feet					1685
?	224	to	224	=	1461
1st S. S.	28	"	252	=	1433
?	205	"	457	=	1228
2d S. S.	18	"	475	=	1210
?	85	"	560	=	1125
3d S. S.	22	"	582	=	1103
?	120	"	702	=	983
4th S. S. ... not through it.	40	"	742	=	943

No well on this farm has drilled through the 4th sand though some have gone 80′ into it. No oil is obtained below 10 to 20 feet from the top of the rock. At the present time this well is being drilled deeper into the sand.

Most of the wells in Dennis Run use gas pumps. [Nov. 4th, 1869.]

141. *Jocelyn Well, No.* 1. (294)

April 14, 1866.

Located on lease No. 1, plot 7, section C of the Jocelyn Oil Lands (old Green Farm), 4½ miles south-east of Pleasantville, and 3 miles south of Neilltown, Forest Co. Authority, A. H. Jocelyn, Vice-President.

Well mouth above ocean in feet					1597
?	112	to	112	=	1485
1st Mt. S. S.	50	"	162	=	1435
?	150	"	312	=	1285
2d Mt. S. S.	25	"	337	=	1260
?	243	"	580	=	1017
1st Oil S. S.	78	"	658	=	939
?	27	"	685	=	912
2d S. S.	25	"	710	=	887
?	70	"	780	=	817
3d S. S.	45	"	825	=	772
?	17	"	842	=	755
4th Extra S. S. ... white pebble.	15	"	857	=	740
?	143	"	1000	=	597

Wet hole. Not cased. Pumped at 800′ from top.

Best production 1 barrel per day. Little gas. Black oil. Gravity 40° and 47°. Mud vein 790′ to 798′.

Digitized by Google

"Owing to accident, losing tools in this well, and fishing for them several weeks in a stiff mud vein at top of the pebble rock, the well was spoiled. She was afterwards drilled to 1000′ as an experiment, to ascertain the fullest extent of Geology, but found nothing of importance below 857′, and the full regular oil-bearing rocks ending at 857′. It is my opinion, after careful study and practical knowledge, that this land is equal to the best oil territory, and with further developments will prove an extended oil field. This geology differs from all below on Stewart's Run."

The foregoing records are published to secure them against accidental loss by fire or otherwise, and to place them in a convenient form for reference. Many of them are imperfect, and some, without doubt, do not correctly represent the stratification of the rocks drilled through; still they are of great value, and when the whole series is completed there will be a sufficient number of approximately reliable ones to exhibit in a very satisfactory manner the general underground structure to any one who will take the trouble to study it out. Their value will be more apparent years hence than it is now, when the old districts are again worked over, as they undoubtedly will be, and the early records are not otherwise to be obtained. During the first development of a district, when scores of wells are in operation, almost every well owner or employé has a knowledge of the rocks sufficient for all practical purposes; but when the district has become partially exhausted, and the original operators have moved forward to other fields, leaving new men behind who know very little of the history of the wells, then these printed records will be sought after and appreciated.

If this plan of preserving records had been adopted when oil was first discovered and followed up to the present time what a vast amount of valuable material would now be accessible to all. Thousands of faithfully kept registers have been made. Some were merely written in a convenient place on the derrick or engine house and perished with the well; some were kept in daily hand-books which were discarded and destroyed as they became old; many have been consumed by fire, that inevitable visitant of all our oil towns; and others are now stowed away among the oil region relics of those who have left the country, and scattered almost to the four corners of the earth. Scarcely one in a hundred of them can now be found.

Those who have well records in their possession can now have them published and preserved with the papers of the survey by mailing them to the headquarters of the Oil District at Pleasantville, Pennsylvania. They will be printed in pamphlet form from time to time as they accumulate in sufficient numbers, for free distribution to those who have contributed them.

In examining these records it will be observed that the first column of figures gives the thickness of each sand-rock or interval; the second, the depth from the surface to both the top and bottom of each sand rock or interval; and the third, the elevation above ocean (where it is known), so that it can be seen at a glance, without any calculation, just what the thickness of each formation is, how far it lies below the surface, and how high above the ocean. This form of keeping records if universally adopted will be found to greatly facilitate their comparison and study.

Digitized by Google

On Centres of Aggregation and Dissociation.

By Pliny Earle Chase, LL.D., Professor of Philosophy in Haverford College.

(*Read before the American Philosophical Society. Jan. 5, and Feb. 2, 1877.*)

I. *Æthereal Influences in the Solar System.*

The velocity of rotation varies as the square root of the velocity of gravitating fall. Therefore, if the velocity of planetary revolution ($\sqrt{gr}$) at Sun's equatorial surface be taken to represent the velocity of æthereal rotation at the same point, the present æthereal atmospheric limit, at which the equatorial velocity of rotation would be equal to that of the æthereal undulations which drive particles towards centres of inertia, is near the outer limit of the asteroidal belt, at ($\sqrt{\text{Light-Modulus}} = 688.3$ solar radii $=$ 3.204 Earth's mean vector-radii). The mean proportional between Earth's mean distance and Saturn's* secular aphelion is 3.216........(1.)

We have found that the velocity at the æthereal atmospheric limit (the velocity of light), is the limiting mean radial velocity, at the point of equilibrium between the velocity of complete dissociation and the velocity of incipient aggregation. The limiting tangential velocity, at the point of equilibrium between complete aggregation and incipient dissociation, is, therefore,† $\frac{1}{\pi}$ of the velocity of light, which is the velocity of æthereal rotation at 219.09 solar radii, Earth's mean distance being 214.86........(2.)

We have also found‡ that Jupiter, the largest extra-asteroidal, and Earth, the largest intra-asteroidal planet, are connected by a common limiting radial velocity, the indications pointing to nucleal or rotating influences in the case of Earth, and to atmospheric or orbital influences in the case of Jupiter. Circular-orbital velocity varies as $g^{\frac{1}{4}}$. The relations of g to $\sqrt{M}$ (1) and of Earth's position to the unit of solar aggregation (2), lend importance to the approximate equality between log. $(\sqrt{M})^{\frac{1}{4}} = .709444$ and log. rad. vec. ($♃ : \oplus$) $=$ .716237.. ....(3.)

Alexander showed§ that Jupiter and Saturn are so related as to suggest a possible early mutual participation in a common nucleal *vis viva*; as if they had been formed, by interior and exterior condensation, from the same nebulous belt. I have shown‖ that the atmospheric radius varies as the $\frac{4}{3}$ power of the nucleal radius. Therefore, if $M^{\frac{1}{3}}$ represents Jupiter's posi-

*"Fundamental Propositions of Central Force," (*ante*. p. 293–310) VI.

†Ib., V.

‡Ib., V—VII, Illustrations.

§Smithsonian Contrib., 280, p. 88.

‖"Fundamental Propositions," X.

Digitized by Google

tion(3) at the extremity of a nucleal radius, the corresponding atmospheric radius $= (\sqrt[8]{M})^{\frac{4}{3}} = M^{\frac{1}{6}}$, of which the logarithm is .945926. The log. of ♄ secular perihelion ÷ ⊕ mean radius vector is .941236.............(4.)

The secular perihelion of Venus is near the æthereal nucleal limit (1, 4). Log. $(\sqrt{M})^{\frac{3}{4}} = 2.128332$, log. ♀ sec. perihelion being 2.159680. 2.159680 — 2.128332 = .031348 = log. 1.07483. ♀ secular aphelion ÷ mean r. vec. = 1.07633..(5.)

These approximations point to æthereal influences on the principal planets, both in the supra- and in the infra-asteroidal belts, and to early special nucleal condensation in the inner belt. The latter indication is strengthened by the greater density of the interior planets, by the many harmonic relations which are based on Earth's distance as a primitive unit, and by Earth's position near the centre of the infra-asteroidal belt. Mercury's secular perihelion (.29743) + Mars's secular aphelion (1.73633) = 2.03376; 2.03376 ÷ 2 = 1.01688. Earth's present aphelion = 1.01678................(6.)

The nucleal-atmospheric relations of Earth and Jupiter (3) are further shown by the fact that a nucleal expansion of Sun to Earth's secular perihelion (200.307 solar radii) would involve an atmospheric expansion to $(200.307^{\frac{4}{3}} = 1172)$. Jupiter's mean aphelion = 1166.61 solar radii....(7.)

The present Light-Modulus (log. M ÷ ⊙r = 5.675554) : Earth's accelerative radius (log. 2 ρ^2 = 4.965340) : : Jupiter's secular aphelion (log. = .741881) : Earth's secular aphelion (log. = .028463)...................(8.)

Earth's rotating, relatively to its orbital velocity, has been accelerated 366.256 times, since its theoretical nebular rupture. This represents the ratio of Earth's nucleal-rupturing to Sun's aggregating radius (2). For if we let ρ = superficial radius and velocity of perfect fluidity in the æthereal nucleus (1), $\rho\sqrt{2}$ = radius of dissociating velocity, and 2 ρ^2 = radius of rupturing *vis viva*. Log. (ρ = ⊕ secular perihelion) = 2.301695. Log. (2ρ^2 ÷ 219.0894) = 2.563791 = log. 366.253.........................(9.)

The increased acceleration of Jupiter's angular velocity, relatively to its nucleal companion Earth, is such as would be due to the difference of orbital velocities at the outer and inner edges of the Jovi-Telluric belt. Log. ♃ secular aphelion (.741881) — log. ⊕ sec. perihelion ($\bar{1}$.969540) = log. 2.433^2. 24 hours ÷ 2.433 = 9 h. 51 m. 49 s.........................(10.)

Jupiter's rotating, relatively to its orbital velocity, has been accelerated in the ratio of its mean rupturing radius to Sun's aggregating radius. For log. (ρ = ♃ mean perihelion) = 3.029231; log. (2ρ^2 ÷ 219.0894) = 4.018865 = log. 10443.97; 4332.585 dy. ÷ 10443.97 = 9 h. 57 m. 22 s. See (7) 35) (48)..(11.)

Saturn's rotating, relatively to Jupiter's orbital velocity, has been accelerated in the ratio of Jupiter's nucleal rupturing to Sun's aggregating radius. For log. (= ♃ sec. per.) = 3.021137; log. (2ρ^2 ÷ 219.0894) = 4.022677 = log. 10′61.83; 4332.585 dy. ÷ 10061.83 = 10 h. 20 m. 3 s........(12.)

Saturn's rotating, relatively to its orbital velocity, has been accelerated

Digitized by Google

in the ratio of its initial-rupturing radius to Earth's radius of rupture. For log. ($\rho =$ ♄ sec. aph.) $= 3.346812$; log. $(2\rho^2 \div 200.307) = 4.391929 =$ log. 24656.36 ; 10759.22 dy. $\div 24656.36 =$ 10 h. 14 m. 4 s..........(13.)

The rotating velocity of Mars, relatively to its orbital velocity, has been accelerated nearly in the ratio of its nucleal-rupturing radius to Earth's secular aphelion. For log. ($\rho =$ ♂ sec. per.) $= 2.449775$; log. $(2\rho^2 \div 229.413) = 2.839962 =$ log. 691.77 ; 686.98 dy. $\div 691.77 =$ 23 h. 49 m. 49 s..........(14.)

The rotating velocity of Venus, relatively to its orbital velocity, has been accelerated in the ratio of its mean rupturing radius to Earth's mean perihelion. For log. $\rho = 2.191493$; log. $(2\rho^2 \div 207.583) = 2.366824 =$ log. 232.715 ; 224.7 dy. $\div 232.715 =$ 23 h. 18 m. 36 s..........(15.)

The rotating velocity of Mercury, relatively to its orbital velocity, has been accelerated in the ratio of its initial-rupturing radius to Sun's aggregating radius. For log. ($\rho =$ ☿ sec. aph.) $= 1.990608$; log. $(2\rho^2 \div 219.0894) = 1.941619 =$ log. 87.422 ; 87.97 dy. $\div 87.422 =$ 24 h. 9 m. 2 s..........(16.)

Jupiter's secular aphelion (5.5193) is a mean proportional between Earth's mean distance, and Neptune's secular aphelion (30.4696). See also, *infra* (27) to (29)..........(17.)

The secular perihelion of Uranus, or its locus of nebular rupture (17.688), is at the centre of the supra-asteroidal belt. For Neptune's secular aphelion (30.470) + Jupiter's secular perihelion (4.886) $= 35.356$; $35.356 \div 2 = 17.678$..........(18.)

The secular perihelion of Uranus is also a mean proportional between Saturn's secular aphelion (10.343) and Neptune's mean aphelion (30.336)..........(19.)

• The centres of the outer and inner planetary belts are so related that the mean distances of Uranus (19.184) and Earth's secular perihelion (.932), are at apses of a major-axis which would be traversed by light undulations in the time of planetary revolution at Sun's surface. ($19.184 + .932 = 20.116$; $688.3 \times 2\pi \div 214.86 = 20.128$)..........(20.)

The major-axis of the November meteoric orbit is also nearly equivalent to the major-axis of these primeval light undulations. For the meteoric period $= 33.25$ yr.; $2 \times 33.25^{\frac{2}{3}} = 20.68$..........(21.)

When Sun's surface of dissociation was at the extremity of Earth's mean radius vector, the locus of complete association, or the vertex of the stellar-solar paraboloid*, was at Mercury's present perihelion (.3187). $1 \div \pi = .3184$..........(22.)

The orbital velocity varies (3) as the one-fourth power of the gravitating velocity. The orbital velocity at the mean aphelion of the intra-asteroidal belt, is equivalent to the mean velocity of the centripetal gravitating im-

* Ib. X, Illustrations. By an inadvertence it was stated that there are nine abscissas between Neptune and α Centauri. There were nine in my original paraboloid (Proc. S. P. A., Sept.20, 1872), but if the vertex is taken at the locus of complete solar aggregation there are eighteen.

Digitized by Google

pulses beyond the belt. For log. (sec. aph. ♆ × sec. aph. ♂)$^{\frac{1}{3}}$ = .215437; log. mean aph. ♂ = .215944..................................(23.)

The mean velocity of the centripetal gravitating impulses in the principal nucleal belt is equivalent to the same orbital velocity. For log. (sec. aph. ♄ × mean ♃)$^{\frac{1}{3}}$ = .216362..................................(24.)

There is, therefore, an equivalence between the mean exterior and the mean nucleal gravitating impulses, beyond the Telluric belt. For log. (sec. per. ♆ × sec. aph. ♂)$^{\frac{1}{2}}$ = .855866; log. (sec. aph. ♄ × mean per. ♃)$^{\frac{1}{2}}$ = .855450..................................(25.)

The orbital velocity varies as the one-half power of the rotating velocity. The mean orbital velocity due to nebular action in the Neptuno-Uranian belt, is equivalent to the rotating velocity at the locus of nebular rupture in the principal nucleal belt. For log. (mean per. ♆ × mean ♅)$^{\frac{1}{4}}$ = .689039; log. sec. per. ♃ = .688982..................................(26.)

The initial rupturing position of the centre of planetary mass (17) is determined by the mean influence of the intra-asteroidal centres (6), the supra-asteroidal centre (18), and the nebular centre of planetary inertia (♄). For log. (mean ⊕ × sec. per. ♅ × mean ♄)$^{\frac{1}{3}}$ = .742338; log. sec. per. ♃ = .741881..................................(27.)

The same position is also a mean proportional between the centre of the supra-asteroidal and the outer limit of the intra-asteroidal belt. For log. (sec. per. ♅ × sec. aph. ♂)$^{\frac{1}{2}}$ = .743575..................................(28.)

The nebula-rupturing position of the centre of planetary mass is at the centre of the initial planetary system. For sec. aph. ♆ (30.470) — sec. aph. ♅ (20.679) = 2 × sec. per. ♃ (4.886)..................................(29.)

The initial position of mean planetary inertia is determined by the mean positions of the rupturing loci of the two principal two-planet belts. For log. (♅ × ♃)$^{\frac{1}{2}}$ = .999588; log. mean aph. ♄ = 1.000003..................................(30.)

The atmospheric limit (4) of the infra-asteroidal belt, is determined by positions of Sun, Jupiter, and Neptune. For log. ($\overline{♃ \times ♆}^{\frac{1}{2}}$ ÷ ☉ r) = 3.429079; log. (sec. aph. ♂ ÷ ☉ r)$^{\frac{4}{3}}$ = 3.429048..................................(31.)

The atmospheric limit of the initial position of the infra-asteroidal centre, is determined by positions of Sun, Jupiter, and Saturn. For log. ($\overline{\text{sec. per. ♃} \times \text{sec. per. ♄}}^{\frac{1}{2}}$ ÷ ☉ r) = 3.147264; log. (sec. aph. ⊕ ÷ ☉ r)$^{\frac{4}{3}}$ = 3.147491..................................(32.)

The atmospheric limit of the initial tendency to infra-asteroidal rupture, is determined by positions of Sun, Jupiter, and Earth. For log. ($\overline{\text{mean per. ♃} \times ⊕}^{\frac{1}{2}}$ ÷ ☉r) = 2.680693; log. (sec. aph. ☿ ÷ ☉r)$^{\frac{4}{3}}$ = 2.680615..................................(33.)

The atmospheric limit at the inner locus of infra-asteroidal rupture, is

the nucleal rupturing limit, relatively to Earth, of Mars. For log. (sec. per. ☿ ÷ ⊙r)$^{\frac{2}{3}}$ = 2.420721 = log. 1 226 ⊕r.vec.; (sec. per. ♂ ÷ ⊕)$^{\frac{2}{3}}$ = 1.225..(34.)

The atmospheric limit at the central locus of infra-asteroidal rupture, is at Jupiter's mean aphelion. For log. (sec. per. ⊕ ÷ ⊙r)$^{\frac{2}{3}}$ = 3.068927; log. (mean aph. ♃ ÷ ⊙r) = 3.066748..............................(35.)

The atmospheric limit at the rupturing locus of Mars, is near the rupturing limit of Saturn. For log. (sec. per. ♂ ÷ ⊙r)$^{\frac{2}{3}}$ ÷ ⊕r.vec. = .934212; log. sec. per. ♄ = .941236; .941236 − .934312 = .007024 = log. 1.0163. This indicates a similarity of contraction at the centre (6) and at the outer limit of the belt..(36.)

The atmospheric limits of the Venus belt, as determined by reference to the rupturing position of Mercury, are in or near the Earth belt. For log. (♀ ÷ sec. per. ☿)$^{\frac{2}{3}}$ ÷ ⊕r. vec. = $\bar{1}$.942238 @ .024175; log. ⊕ = $\bar{1}$.969540 @ .028463..(37.)

The atmospheric limits of the Earth belt, referred to the rupturing position of Mercury, are within the Mars belt. For log. (⊕ ÷ sec. per. ☿)$^{\frac{2}{3}}$ = .131591 @ .210155; log. ♂ = .117620 @ .239631......................(38.)

The atmospheric limits of the Mars belt, referred to the rupturing position of Mercury, are within the asteroidal belt......................(39.)

The atmospheric limit at Venus's mean aphelion, referred to Mercury's mean locus, is at Earth's rupturing locus. For log. (mean aph. ♀ ÷ ☿)$^{\frac{2}{3}}$ = .382120; log. (sec. per. ⊕ ÷ ☿) = .381719......................(40.)

The atmospheric limit at Earth's initial locus, referred to the initial locus of Mercury, is at the mean perihelion of Mars. For log. (sec. aph. ⊕ ÷ sec aph. ☿)$^{\frac{2}{3}}$ = .466876; log. (mean per ♂ ÷ sec. aph. ☿) = .468819..(41.)

The initial locus of Earth is at the mean aphelion thermal radius of Venus. For log. 1.4232 (mean aph. ♀ ÷ ⊕) = .027677; log sec. aph. ⊕ = .028463..(42.)

The atmospheric limit at the rupturing locus of Mars (36), referred to the rupturing position of Venus, is near the mean aphelion of Mars. For log. (sec. per. ♂ ÷ sec. per. ♀)$^{\frac{2}{3}}$ = .214318; log. mean aph. ♂ = .215944..(43.)

The inner atmospheric limit of the Jupiter belt, referred to the rupturing position of Venus, is at Saturn's mean distance. For log. (sec. per. ♃ ÷ sec. per. ♀)$^{\frac{2}{3}}$ = .976134; log. ♄ = .979496..................(44.)

The outer atmospheric or initial limit of the Jupiter belt, referred to the rupturing position of Venus, is near Saturn's initial locus. For log. (sec. aph. ♃ ÷ sec. per. ♀)$^{\frac{2}{3}}$ = 1.046666; log. sec. aph. ♄ = 1.014657; 1.046666 ÷ 1.014657 = .032009 = log. 1.077 = log. (sec. aph. ÷ mean ♅). See (8) to (5), (20)......................... ....(45.)

Digitized by Google

The inner atmospheric limit of the Saturn belt, referred to the rupturing limit of Venus, is at the secular aphelion of Uranus. For log. (sec. per ♄ ÷ sec. per. ♀)$^{\frac{4}{3}}$ = 1.312473 ; log. sec. aph. ♅ = 1.315531........(46.)

The outer atmospheric limit of the Saturn belt, referred to the rupturing position of Mars, is also at the secular aphelion of Uranus. For log. (sec. aph. ♄ ÷ sec. per. ♂)$^{\frac{4}{3}}$ = 1.313669................................(47.)

The inner atmospheric limit of the Jupiter belt, referred to Earth's rupturing position, is near Saturn's rupturing position. For log. (sec. per. ♃ ÷ sec. per. ⊕)$^{\frac{4}{3}}$ = .928796 ; log. sec. per ♄ = .941236 ; .941236 — .928796 = log 1.029. .... (48.)

The outer atmospheric limit of the Jupiter belt, referred to Earth's rupturing position, is at the mean aphelion of Saturn. For log. (sec. aph. ♃ ÷ sec. per. ⊕)$^{\frac{4}{3}}$ = .999328 ; log. mean aph. ♄ = 1.000003..........(49.)

The mean atmospheric limit of the Saturn belt, referred to Earth's mean position, is near the mean aphelion of Uranus. For log. (♄ ÷ ⊕)$^{\frac{4}{3}}$ = 1.305995 ; log. mean aph. ♅ = 1.301989 ....(50.)

The atmospheric limit at Jupiter's mean aphelion, referred to the rupturing position of Mars, is at Saturn's rupturing position. For log. (mean aph. ♃ ÷ sec. per. ♂)$^{\frac{4}{3}}$ = .940244 ; log. sec. per ♄ = .941236......(51.)

The mean atmospheric limit of the Uranus belt, referred to Jupiter's rupturing position, is at Neptune's mean aphelion. For log. (♅ ÷ sec. per. ♃)$^{\frac{4}{3}}$ = 1.480913 ; log. mean aph. ♆ = 1.481951.........................(52.)

The same limit (52), referred to Jupiter's mean perihelion, is at Neptune's mean locus. For log. (♅ ÷ mean per. ♃)$^{\frac{4}{3}}$ = 1.478215 ; log. ♆ = 1.477611...(53.)

The same limit, referred to Jupiter's mean position, is at Neptune's rupturing position. For log. (♅ ÷ ♃)$^{\frac{4}{3}}$ = 1.471828 ; log. sec. per. ♆ = 1.471268...(54.)

The important influence of Earth's position at a centre of early nucleal condensation, is also shown by the simplicity of relations between Earth's radius vector and the secular epicyclical undulations of the supra-asteroidal planets.

Earth and Sun are convertible points of suspension, for a linear pendulum equivalent to the secular excursion of Uranus. For 3 ÷ 38.365 = .0782 ; the maximum eccentricity of Uranus is .0780 ; see (20) (21)........ (55.)

The excursion of Saturn is nearly equivalent to the atmospheric limit of a nucleus which has Earth's thermal radius ($1.4232^{\frac{4}{3}}$ = 1.601). For 1.601 ÷ 19.078 = .0839 ; the maxium eccentricity of Saturn is .0843........(56.)

The excursion of Jupiter is equivalent to the mean radius of rotating inertia at Earth's mean distance ($\sqrt{.4}$ = .6325). For .6325 ÷ 10.406 = .06078 ; the maximum eccentricity of Jupiter is .06083...............(57.)

The excursion of Neptune is in the inverse ratio of its own coefficient

Digitized by Google

($\frac{4}{9}$) and in the direct ratio of the coefficient of Uranus ($\frac{7}{8}$), in the abscissas of the stellar-solar paraboloid which has its vertex at the point of complete solar aggregation.* For $\frac{7}{8} \div 60.074 = .0147$; the maximum eccentricity of Neptune is .0145. ....(58.)

The following table shows the closeness of approximation (Theoretical less Observed ÷ Observed), in each of the foregoing comparisons:

1	—.0039	15	.0052†	30	—.0010	45	—.0009
2	.0197	16	—.0028†	31	.0001	46	—.0070
3	—.0158	17	.0001	32	—.0005	47	—.0048
4	.0109	18	—.0006	33	.0002	48	.0291
5	—.0014	19	.0019	34	.0008	49	—.0016
6	.0001	20	.0006	35	.0050	50	.0093
7	.0033	21	—.0224	36	.0006	51	—.0028
8	.0074	22	—.0013	37	.0000	52	—.0025
9	.0000	23	—.0012	38	.0000	53	—.0014
10	.0070†	24	.0010	39	.0000	54	—.0013
11	—.0023†	25	.0010	40	.0009	55	.0030
12	.0169†	26	.0001	41	—.0045	56	—.0050
13	.0238†	27	.0011	42	—.0018	57	—.0008
14	.0319†	28	.0039	43	—.0038	58	.0014
		29	.0019	44	—.0078		

One of the most important corollaries of the theory of universal gravitation, is tersely stated by Stockwell,‡ as follows: "The amount by which the elements of any planet may ultimately deviate from their mean values can only be determined by the simultaneous integration of the differential equations of these elements, which is equivalent to the summation of all the infinitesimal variations arising from the disturbing force of all the planets of the system during the lapse of an infinite period of time." Therefore, within the limits of secular eccentricity, the result is the same *as if* the nebular hypothesis were true.

There should, then, be tendencies, in the neighborhood of every inert particle which floats in an elastic medium, to the formation of harmonic nodes of various kinds, and the sum of such tendencies should fix loci of cosmical aggregation before there had been any considerable shapings of definite mass. The subsequent values of relative mass would depend upon mutual conditions of equilibrium between various forms of living force.

But such accordances as the foregoing, however interesting, and however striking they might be deemed, would furnish no more conclusive evidence of the nebular theory, as popularly interpreted, than of the Cartesian vortices. All assumptions as to the nature of ultimate physical force, are now, and perhaps always will be, mere assumptions; still, like geometrical diagrams, they may help to fix the mind upon ultimate physical resultants, and thus serve a useful purpose.

* Ib. † According to Herschel's estimate.

‡ Smithsonian Contributions, 232. viii.

Digitized by Google

Stockwell also remarks* that "a comparison of the values which the different solutions give for the superior limit of the eccentricity of the Earth's orbit, has suggested the inquiry whether there may not be some unknown physical relation between the masses and mean distances of the different planets." If such a relation exists, the constancy of the mean distances would also seem to imply a like constancy of absolute or relative masses, and the inquiry naturally arises, which is the logical antecedent; whether distance has determined mass or mass has determined distance.

There is abundant evidence on the one hand, of "cosmical dust," and meteorites, which are contributing to the enlargement of the sun and the planets; on the other, of internal convulsions, which are occasionally ejecting materials beyond the reach of primitive attraction. It is commonly believed that the enlarging tendencies predominate, and that the sum of all physical tendencies is towards stagnation, death, and universal gloom. Such a belief seems to me erroneous, and based upon limited considerations. It is not easy, as yet, to trace all the compensative and restorative energies, but some of them are strongly indicated by the various cosmical relations which, through all periodic and secular inequalities, tend to maintain the stability of planetary orbits.

In judging of the probable logical antecedence, it is well to remember, that all of the correlations which I have pointed out have been based upon general considerations of oscillatory centres, as influenced by radial, tangential, superficial, and volumetric disturbances, with reference to simple centres of inertia, and entirely independent of mass. My own convictions that spirit must necessarily, both logically and chronologically, take precedence of matter, have been strengthened by my investigations. Others, who have been accustomed to look more exclusively to physical influences, may perhaps be differently impressed by them. If they can give any physical explanation of the instantaneous action of gravity at all distances, or if they can frame any satisfactory hypothesis to account for such action except by constant spiritual activity, it will be gladly welcomed by all sincere seekers after truth. If, on the other hand, they admit that instantaneous action is incompatible with inertia, they may find that their own studies of nature lead them to a sure recognition of the supernatural, as an essential element of sound and catholic philosophy.

If a nebulous mass were to be divided by some internal convulsion, the ruptured portions would be projected from their common centre of gravity to distances varying inversely as their masses. If the first rupture were simple and one mass were much larger than the other, it could not obey the tendency to revolve about the common centre of gravity in a time proportional to the $\frac{3}{2}$ power of the distance, but the tendency might be manifested in other equivalent ways. The synchronism of linear oscillations through twice the diameter, and orbital oscillations through the circumference of a circle, points to a possible mode of such manifestation, by the removal of the larger mass to such distance as would allow the linear oscillations, or equivalent

* Op. cit., xvii.

Digitized by Google

tangential oscillations. This is the case with Sun and Jupiter. For if we represent the mass of Jupiter by 1, and Sun's mass by n, the secular perihelion distance of their centres, $.9391726 \times 5.2028 \times 214.86\, r = (n + 2)\, r$; and $n = 1047.876$. Bessel's value is 1047.879 .... (59.)

The atmospheric relation of Saturn to Jupiter (51) is further shown by the equality of nebular *vires vivæ*. For orbital $v.\ v. \propto \frac{m}{r}$; the nebulous mass at Jupiter's thermal radius vector,* is 1.4232^3, and the orbital $v.\ v.$ at the corresponding atmospheric limit is $1.4232^3 \div 1.4232^{\frac{4}{3}} = 1.4232^{\frac{5}{3}} = 1.8007$, which is Alexander's ratio.† The $v.\ v.$ of constrained rotation varies as the square of the orbital $v.\ v.$, or, in the present case, as 3.2426 to 1, which would require masses in the ratio of 1 to 3.2426 to give equality of $v.\ v.$; provided the primitive orbits were circular. We have seen, however, (6), that the infra asteroidal centre is at $1.01688 \times$ Earth's mean distance, and the Jovi-Telluric connections (8) suggest the probability of a similar eccentricity in the primitive Jovi-Saturnian belt. $(1.4232^{\frac{5}{3}} \times 1.01688)^2 = 3.3525$; $1047.876 \times 3.3525 = 3513.47$. Bessel's ratio of Sun to Saturn is 3501.6; Le Verrier's 3512 .... (60.)

Saturn's position at the nebular centre of planetary inertia would be likely to establish permanent records of equality in still other forms of *vis viva*. We accordingly find that the ratio of Neptune's to Saturn's mass seems to be due to nucleal *vis viva* (4) when they were both at atmospheric limits. For the $v.\ v.$ of nucleal rotation varies as $\left(\frac{1}{d}\right)^{\frac{3}{2}}$; the $\frac{3}{2}$ power of Neptune's, divided by Saturn's mean distance, $= 5.587$; $5.587 \times 3513.47 = 19630$. Newcomb's ratio of Sun to Neptune, as deduced from the perturbations of Uranus is 19700 .... (61.)

The mass ratio of Uranus to Saturn seems to be due to atmospheric *vis viva* when their nucleal condensation began. For the $v.\ v.$ of rotation at the atmospheric limit varies as $\left(\frac{1}{d}\right)^{\frac{8}{3}}$; the $\frac{8}{3}$ power of mean distance (♅ ÷ ♄) is 6.444; $6.444 \times 3513.47 = 22641$; Newcomb's ratio of Sun to Uranus is 22600 ± 100 .... (62.)

The mass ratio of Saturn to Earth seems to be due to equality of rotating *vis viva*. For the $v.\ v.$ of rotation in a contracting nucleus varies as $\left(\frac{1}{d}\right)^2$; the square of mean distance (♄ ÷ ⊕) is 90.99; $90.99 \times 3513.47 = 319690$. The ratio of Sun to Earth is still a mooted question...... (63.)

These theoretical masses are such as to contribute to the stability of the system, by giving equality between various forms of opposing $v.\ v.$ at culminating points of opposing disturbance.

With the Sun expanded to Neptune's mean aphelion and rotating as a

* Fundamental Propositions, III, IV.

† Proc. S. P. A. xii. 394.

Digitized by Google

nebulous mass, at the beginning of interplanetary condensation (secular aphelion) the mean *vires vivæ* of the outer two-planet belts are equal. For the internucleal *v. v.* $\propto md^2$; log. md^2 (♆ × ♅) = 5.656948 ;* log. md^2 (♄ × ♃) = 5.656817. See also (58)........................(64.)

With Neptune at secular aphelion the mean *vires vivæ* of the outer and inner limits of the outer two-planet belts are equal. For under uniform æthereal resistance the *v. v.* is proportioned to the product of the mass by the trajectory, and the mean orbital trajectory is proportioned to the mean distance. Taking Uranus, Saturn and Jupiter at their mean distances, log *md* (♆ × ♄) = 3.334505 ; log *md* (♅ × ♄) = 3.333751..(65.)

With Jupiter at Sun's nucleal surface, and the outer planets at tidal crests (secular aphelion), the mean *v. v.* of the two outer = mean *v. v.* of the two inner planets. For the *v. v.* of rotation in a shrinking nucleus $\propto m \div d^2$; the orbital *v. v.* $\propto m \div d$; log. (♃ *rot.* × ♆ *orb.*) *v. v.* = $\bar{2}$.480226 ; log. (♅ × ♄) *orb. v. v.* = $\bar{2}$.478969.......................(66.)

In my equation of figurate powers, log. (♆ × ♅^{3} × ♃^{6}) = 8.069488 ; log. ♄^{10} = 8.091570 ; log. ♄ theoretical mass = .806949 ....(67.)

The internucleal *v. v.* ($\propto md^2$) of Saturn is equivalent to the mean internucleal *v. v.* of the supra-asteroidal belt. For if we consider Neptune at secular aphelion, Uranus and Saturn at mean distance, and Jupiter at secular perihelion, log. md^2 for ♆ = 3.029720 ; for ♅ = 2.565859 ; for ♄ = 2.768149 ; for ♃ = 2.712548 ; (3.029720 + 2.565859 + 2.768149 + 2.712548) ÷ 4 = 2.769069 ....(68.)

The mean *v. v.* of æthereal rupturing projection (*md*) in the supra-asteroidal belt is equivalent to that of the Sun (59). For log. [mass (♆ × ♅ × ♄ × ♃) ¼ ÷ ☉ × secular perihelion ♆ ÷ ☉ radius] = ¼ ($\bar{5}$.707091 + $\bar{5}$.645107 + $\bar{4}$.454264 + $\bar{4}$.979691) + 3.803423 = $\bar{1}$.999961 ; log. mass ☉ ÷ ☉ radius = .000000....................................(69.)

Jupiter's mass is nearly equivalent to the mean mass of Sun, Earth and Saturn. For log. ⅓ (☉ × ⊕ × ♄) = 1.338072 ; log. ♃ = 1.334584...(70.)

II. *Chemical Atoms, Molecules and Volumes.*

In accordance with a suggestion of Professor Robert E. Rogers, I have endeavored to find what modes of central force will best represent some of the most general forms of chemical activity, more especially those which are the basis of the law of Avogadro and Ampére, of combination by volume, and of approximate constancy in the product of atomic weight by specific heat.

The simplicity of the ratio, between the energy of H_2O and the solar energy at Earth's mean distance,† furnishes good grounds for such an investigation, while the record of a parabolic orbit, connecting the Sun with the nearest fixed stars,‡ indicates a proper course for conducting it. Al-

* With Uranus as unit of mass, and Earth as unit of distance.

† *Ante* xii, 394; xiii, 142.

‡ *Ante*, xii, 528, and subsequent papers.

Digitized by Google

though there may be some doubt as to the degree of certainty which belongs to the recent hypotheses of internal gaseous structure, there can be none as to the graphic representation of orbital activities under forces varying inversely as the square of the distance. Circular orbits denote constancy of relations between radial and tangential forces; elliptic orbits, variability of relations accompanied by cyclical oscillations; parabolic orbits, variability of relations without cyclical oscillation; hyperbolic orbits, variability of relations complicated by the action of extraneous force.

In a rotating mass, the orbits of the several particles are circular. If the uniform velocity of any particle in the equatorial plane is less than $\sqrt{fr}$, the mean action of the central force is impeded by internal collisions or resistances. If the velocities of all the particles in the plane vary precisely as $\sqrt{fr}$, there is a condition of perfect fluidity, marking a limit between complete aggregation and incipient dissociation. Any cyclic variations of velocity between constant limits indicate elliptic orbits, with tendencies to aggregation through collisions near the perifocal apse. A perifocal velocity of $\sqrt{2fr}$ marks a parabolic orbit, and a limit between complete dissociation and incipient association. A velocity greater than $\sqrt{2fr}$ is hyperbolic, indicating the intervention of a third force in addition to the mutual action between the two principal centres of reference.

If all physical forces are propagated by æthereal undulations between resisting points, those points tend naturally to nodal, and from internodal positions. In order to maintain uniformity in the wave velocity, the æthereal molecules must be uniform, not only in volume, but also in aggregate inertia. As the inertia of the resisting points increases, the inertia due to internal æthereal motions, should, therefore, diminish, and *vice versâ*. In other words, the uniform elementary volume may be represented by the product of atomic weight by specific heat, and the laws of Boyle (or Mariotte), Charles, and Avogadro, follow as simple and necessary corollaries.

In order that uniform undulations should produce motion, there must be at least two points of resistance. Those points would approach each other until the interior undulating resistance equaled the exterior undulatory pressures, when their motion would be converted into rotation or into orbital revolution. Their common centre of revolution might become the centre of a new elementary volume, thus giving rise to the various laws of combination by volume, combination without condensation, condensation of two volumes into one, three volumes into two, or four volumes into two, as well as to general artiad and perissad quantivalence.

When perifocal collisions change parabolic or elliptic into circular orbits, there should be increasing density towards the principal centre of the system. Further collisions and condensations would produce tendencies to both nucleal and atmospheric* aggregations, and consequent binary groupings. These laws are exemplified in the solar system, by the general division into an intra-asteroidal and an extra-asteroidal belt, and by the subdivis-

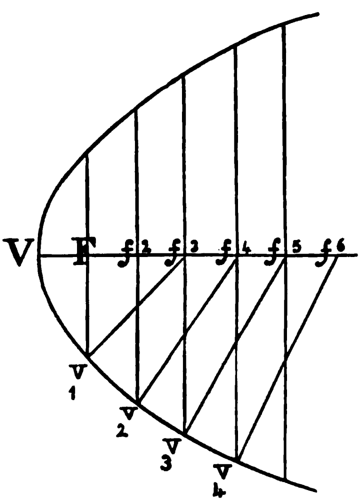
* *Ante*, xiv, 622, sqq.

Digitized by Google

ion of each belt into two pairs, the inner belt being denser than the outer, and the inner member of each pair being denser than its companion; Mercury being denser than Venus; Earth, than Mars; Jupiter, than Saturn; Uranus, than Neptune. This arrangement towards the Sun as a principal centre, appears, however, to be of more recent date than the tendency to condensation in the Telluric belt, for Earth is denser than Venus, and the great secular ellipticities of Mars and Mercury suggest the likelihood of a quasi-cometary origin. Similar tendencies would contribute to the chemical grouping of atoms by pairs, which is essential for polarity and for the already enumerated laws of chemical combination.

In the "nascent state," particles may be regarded either as parabolically perifocal, with the velocity of complete dissociation from a given centre, or as relatively at rest, and ready to obey the slightest impulses of central force. The mean *vis viva* of a system formed by two such particles would be $m \times (\sqrt{2})^2 + m \times 0 = 2\,m \times 1$, representing a change from parabolic to circular orbits and a condensation of two volumes into one.

At the parabolic limit between complete dissociation and incipient aggregation, if the focal abscissa $x_0 = VF$, is taken as the unit of wave-length, the value of the successive ordinates, as well as the velocity communicated by uniform wave influence acting through the entire length of the ordinates, will be represented by $\sqrt{4x_n}$; the resulting *vis viva*, and the consequent length of path, or major axis, communicable against uniform resistance, by $4x_n$; the successive differences of major axis, by 4. Each normal, $v_n f_{n+2}$, equals the next ordinate, $v_{n+1} f_{n+1}$; there are, therefore, triple tendencies, both in the axis of abscissas, and on each branch of the curve, to successive differences of 4 in the major axes of aggregation, in consequence of the meeting of abscissal, ordinal, and normal waves in the axis, and the meeting of tangential, normal, and abscissal waves upon the curve. At each node of aggregating collision two of the wave systems are due to normally alternating rectangular oscillations,* the third serving as a link between the axial and the peripheral waves. The bisection of the normals, by their equivalent ordinates, adds importance to the normal major axes, and increases the tendency to aggregation at their respective centres of gravity.



* "Fundamental Propositions," 13.

Digitized by Google

Chemical molecules and atoms are so small that we are unable, at present, to show, so conclusively as in cosmical gravitation, that the "nascent" velocity, or the mean radial velocity at the limit between complete dissociation and incipient aggregation, is equivalent to the velocity of light. But the analogies, which are here presented, are strengthened by the frequent vivid, luminous and thermal accompaniments of chemical change, and by the electric polarity of combining elements. It seems, therefore, reasonably certain that the same limiting unity of velocity and *vis viva*, which can be easily traced in light, heat, electricity and gravitation, is also fundamentally efficient in chemical affinity. M. Aymonnet, in his communication of a "nouvelle méthode pour étudier les spectres calorifiques,"* says: "Je ferai remarquer, avant de terminer, que l'étude des spectres calorifiques d'absorption, faite avec des corps portés à diverses températures, peut et doit conduire à la connaissance de lois physiques reliant les phénomènes d'association et de dissociation des corps aux phénomènes calorifiques et lumineux." In another paper recently presented to the French Academy, "sur le rapport des deux chaleurs spécifiques d'un gaz,"† M. Ch. Simon deduces the theoretical ratio C : c : : 1.4 : 1. The first attempt at a solution of the problem upon *a priori* grounds, appears to have been Professor Newcomb's,‡ who found from the hypothesis of actual collisions, the ratio 5 : 3 if the particles were hard and spherical, or 4 : 3 if they were hard and not spherical; the second, my own,§ based on the general consideration of all internal motions, which led to the ratio 1.4232 : 1; the third, M. Simon's, which took account of rotations and neglected other internal vibrations.

* Comptes Rendus, lxxxiii, 1102–4, Dec. 4, 1876.
† Ib. 727, Oct. 16, 1876. ‡ Proc. A. A. S., v., 112. § *Ante*, xiv, 651.

Digitized by Google

Contributions from the Laboratory of the University of Pennsylvania.

No. VII.

On astrophyllite, arfvedsonite and zircon, from El Paso Co. Colorado, and a colorimetric estimation of titanium before the blow-pipe.

By George Augustus König, Ph. D.

(*Read before the American Philosophical Society January* 19*th*, 1877.)

General occurrence. The three minerals are imbedded in quartz. On the specimens which I examined no orthoclase, nor any other species could be found; yet the mother rock may be presumed to be a very coarse grained granite or syenite. Until satisfactory information is received on this point, it must, of course, remain doubtful. In stating that the three minerals occur together, it is but right to say, that I make a hearsay statement.

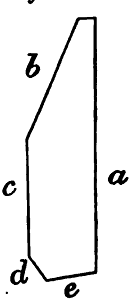
For, the specimens of quartz in which astrophyllite and zircon abound, are destitute of arfvedsonite, and the specimen on which the latter is abundant, does not show either of the two other species. But the character of the quartz, as the common matrix, is strictly identical throughout, of grayish color, locally stained with iron ochre, and massive in structure. The co-occurrence of these three species, at once calls up the close similarity with that of Brevig in Norway, the only locality at which astrophyllite was known to exist. The only difference being that orthoclase forms the matrix at Brevig, and quartz in Colorado.

To Dr. Foote, of this city, I am indebted for the material of this investigation.

I. Astrophyllite.

Geometrical properties. The crystals exhibit elongated prismatic forms, the cross section being nearly a rectangle on the majority of the individuals. I succeeded in finding some crystals, however, whose section is more complicated and with which I endeavored to establish the angular relations between the several faces. No terminal development of any kind could be observed; the crystals appear all broken across the direction of main extension.

The measured edges are, therefore, all in one zone. The figure represents a cross section of the best developed crystal, and the faces are designated a, b, c, etc., solely in reference to their sequence.



a $\wedge$ c = 180° 15′
a $\wedge$ e = 93°
c $\wedge$ e = 87°
d $\wedge$ e = 119°
b $\wedge$ c = 149° 30′
c $\wedge$ d = 148°

Digitized by Google

a is a cleavage face and reflects a sharp image, the other faces are true crystal faces, and, with the exception of c, reflect very imperfectly. The largest face (a) is not quite one-eighth of an inch wide. The measurement does not make any pretension of scientific accuracy for the reasons stated, yet the above angles are the means of repeated observations, which only differed by 1°, for the edges a $\wedge$ e, c $\wedge$ e, and by less than 30′ for the other edges. Their approximate accuracy taken for granted, they clearly admit only an interpretation according to the laws of the monosymetric system, when c becomes the basal plane, e an orthopinakoid, b and d hemidomes.

Scheerer, who first described the species (B. H. Ztg. XIII 240, 1854) arrived at a different result. His measurements lead to an orthorhombic interpretation, and the optical investigations of Des Cloizeau (Dana, mineralogy) corroborate his view. But as none of the angles measured by me, find and analogon in those given by Scheerer, no comparison can be made, and future study must decide the truth.

Structural properties. A very marked cleavage exists parallel to the face c, by which the structure becomes eminently micaceous. The cleavage is indicated on the lateral faces by a decided striation (very plainly visible on the quartz, after the removal of crystals), and re-entering angles. Unlike other micaceous minerals, the laminæ are but very slightly elastic and tenacious, being easily reduced to a fine powder. That the crystals break easily across the main extension has already been mentioned. Hardness about 3.

Optical properties. Color from brass yellow to deep bronze brown. Transmitted light deep yellow to reddish brown. Appearance of the powder at a certain degree of fineness like mosaic gold. I could not obtain an image of interference with a lamina, through which types of ordinary print were plainly visible But not possessing much experience in optical investigation, I have referred it to Professor P. Groth, of Strassburg.

Specific gravity = 3.375 at 15 C°.

Pyrognostic properties. The mineral fuses very readily to a black globule in the flame of an oil lamp. With microcosmic salt the reactions for iron, manganese, titanium and silica are easily obtained.

The mineral decomposes completely with sulphuric acid at ordinary pressure, and very readily in a sealed tube at 140 C°.

Composition :

			Oxygen.	
SiO_2	=	34.68	18.485	24.363
TiO_2	=	13.58	5.299	
ZrO_2	=	2.20	0.579	
Fe_2O_3	=	6.56	1.968	2.294
Al_2O_3	=	0.70	0.326	

Digitized by Google

			Oxygen.	
FeO	=	26 10	5.799	8.256
MnO	=	3.48	0.784	
K_2O	=	5.01	0.851	
Na_2O	=	2.54	0.655	
MgO	=	0.30	0.120	
CuO	=	0.42	0.047	
TaO_5	=	0.80		
H_2O	=	3.54	3.147	3.147
		99.91		

The oxygen ratio becomes:

$$\ddot{R} : \dddot{R} : \dot{R} : \dot{H} .$$
$$32 : 3 : 11 : 4 .$$

$$(H_2O)_4 \ \left[(Si\ Ti\ Zr)\ O_2\right]_{16} \ \left[(Fe_2\ Al_2)\ O_3\right] \ \left[(Fe,\ K,\ Mn,\ Na,)\ O\right]_{11} .$$

To obtain the atomistic symbol, we have:

					Quotients.	Atoms.
Si	=	16.195	:	28	0.578	13.13
Ti	=	9.281	:	50	0.185	4.25
Fe	=	5.090	:	112	0.044	1.00
Fe	=	20.331	:	56	0.363	8.25
Mn	=	2.696	:	55	0.049	1.11
K	=	4.159	:	39	0.107	2.43
Na	=	1.885	:	23	0.081	1.84
H	=	0.393	:	1	0.393	8.93
O	=	38.060	:	16	2.379	54.07

The most rational approach to these figures will be represented by the symbol

$$\left.\begin{matrix} & \overset{IV}{Si}_{13} & \overset{IV}{Ti}_4 \\ \overset{\prime\prime}{Fe}_8 & \overset{VI}{Fe} & \overset{\prime\prime}{Mn} \\ K_3 & Na_2 & H_{10} \end{matrix}\right\} \overset{\prime\prime}{O}_{54}$$

by which all the affinities are satisfied.

Note.—In the above calculation zirconium is converted into its equivalent of titanium, aluminum into ferric iron, magnesium and copper into the bivalent ferrous iron. Tantalic acid was left out, partly because its existence in the mineral is *not* established beyond doubt, and also because the general features of the formula would not be altered by its introduction.

Comparing my analytical results with those of Pisani, Scheerer, et. al. who analysed the Brevig mineral (Dana, mineralogy, ed. 5, 309), whilst a general conformity appears evident, there exists a difference in the percentages of titanium, aluminum and manganese too great to be passed in

Digitized by Google

silence. To facilitate the comparison, the results of the several analyses are placed side by side :

	Pisani.	Scheerer.	Meinecke.	Sieveking.	König.
$Ti\,O_2$	7.09	8.24	8.84	8.76	13.58
$Zr\,O_2$	4.97	——	——	——	2.20
$Al_2\,O_3$	4.00	3.02	3.46	3.47	0.70
$Mn\,O$	9.90	12.63	12.68	10.59	3.48

Excepting Pisani's analysis, there is such close agreement between the others as could only be accounted for by an identical material and the following of precisely the same methods of analysis under the same circumstances. For, if Pisani's analysis is correct, there must be a variation in the composition of the Brevig mineral. Adding the percentages of $Ti\,O_2$, $Zr\,O_2$, $Al_2\,O_3$ in Pisani's analysis, we obtain 16.06, against 16.48 in my analysis, whilst those sums in the other analyses are 11.26, 12.30, 12.23 respectively. But in regard to manganese, it seems evident that the mineral from Brevig and that from Colorado differ considerably, being only one third in the latter of that in the former.

It was stated above, that the astrophyllite is closely associated with zircon, which occurs in all sizes from $\frac{1}{4}$ inch to microscopic size. After the astrophyllite has been picked with all possible care, and is reduced to powder in a mortar, an occasional harsh grit is noticed. This suggests the intimate admixture of a hard, granular mineral, probably zircon, and the zirconia found by analysis might only be derived from admixed zircon. To test this question I decomposed the mineral with sulphuric acid of medium concentration, filtered from the insoluble, and digested the residue with sodium hydrate. A white, sandy residue, of great hardness, was obtained, ranging from 3 to 6 per cent. in different samples. I analysed it by itself, and found it to be a mixture of quartz and zircon. Since zircon, even as finest powder, is not acted upon sensibly by sulphuric acid of medium concentration, and as I had avoided the crushing of the hard grains as much as possible, I feel confident to assert that whatever zirconia was found in the sulphuric solution was in molecular combination as astrophyllite, and not derived from admixed zircon. By the same process I made sure that no titanium was present in the form of rutile or titanite, or any other titanium mineral.

I proceed now with the description of a method for the qualitative and quantitative determination of titanium, zirconium and aluminum, which I believe to be new and especially serviceable when the quantity of the mixed metals is very small. The best method for separating titanium from aluminum is stated to be (Rose, quant. analysis) the boiling of the dilute sulphuric solution, when titanium dioxyhydrate will precipitate. This is only relatively true, depending on the relative quantities of metals and of salts in the solution. If the solution be strongly acid, titanium is not completely precipitated, and in certain cases not precipitated at all. (A detailed account of the behaviour of titanium, zirconium and aluminum

Digitized by Google

will be published hereafter in connection with the reactions of the problematic earth in schorlomite.) If the solution be very neutral, a large percentage of aluminum is precipitated. Owing to this behaviour, titanic dioxyd is often given as alumina, and *vice versa.* When the ferric oxyd, after the supposed precipitation of titanium, is weighed, re-dissolved and estimated by permanganate, the deficit is considered to be alumina, when in reality it is titanium, or zirconium dioxyd. However, my method although applicable to large quantities is more especially designed for small residues, with which precipitations, for physical and chemical reasons, give rise to considerable error.

The mixed oxyds are digested with equal parts of water and concentrated sulphuric hydrate at increasing temperature, until the excess of acid is evaporated. I dissolve now in the smallest possible quantity of water, and bring the liquid upon a watch glass, where a quantity of diammonium sulphate is added, corresponding to the alum equivalent of alumina equal to the weight of the mixed oxyds. A gentle heat is applied until the ammonium salt is dissolved, and the whole is allowed to evaporate spontaneously in a warm place. Under these conditions, titanium, zirconium and aluminum form double salts with ammonium, but those of the two former are very soluble in cold water; while the well-known aluminum double salt, the alum, partly owing to the physical conditions of the crystals, is only slightly soluble in cold water, and still less so in a solution of ammonium or potassium sulphate. Accordingly, the dry mass of salts is moistened with a few drops of cold water, when every salt, but the alum will pass into solution, and the latter salt will be recognized at once, under the lens, by peculiar and constant octahedric forms.

This salt is so granular, that it can readily be freed from accompanying salts by decantation, washing with a solution of ammonium sulphate. Comparative tests showed that this washing process may be continued at length, without effecting a perceptible decrease of the alum. Thus freed from its mother liquor, the crystals may be removed into a small platinum crucible by means of a small piece of filter paper, ignited over the blast lamp, aluminum sesquioxyd obtained in great purity, and its weight ascertained. If the quantity be very small (less than 0.0005 gr.) the filter paper, whose ashes bring in impurity, the crystals may be washed into the crucible with a small amount of boiling water. In this manner I could estimate 0.0001 gr. and obtain a very distinct confirmative test by cobalt nitrate, before the blow-pipe. Experiments demonstrate that the presence of titanium and zirconium sulphates does not interfere with the complete crystallization of aluminum as alum, and as this salt only contains eleven percentum of aluminum sesquioxyd, the sensitiveness of the reaction is readily understood.

Note.—The mixed oxyds must be freed from silica, which is easily accomplished by adding a drop or two of hydrofluoric acid, during their digestion with sulphuric acid.

I am well aware that the determination of aluminum as alum is not new,

Digitized by Google

but I have nowhere in the literature noticed a recognition of its superiority over other methods, and especially none applying to this separation from titanium and zirconium in a micro-chemical sense.

The mother liquor from the alum, containing the sulphates of titanium and zirconium, besides a considerable amount of ammonium sulphate, is evaporated in a platinum capsule (one with a conical apex preferable, as it facilitates the removal of the oxyds after ignition), evaporated to dryness and ignited with caution over a blast lamp. The oxyds are then left in a scaly condition, very finely divided and well adapted to the subsequent treatment. They might be precipitated by ammonium hydrate and then ignited ; but this would cause some inevitable loss, and on the other hand silica would be again introduced by the filter ashes and from the glass vessels, which would interfere with the reactions. The oxyds would be obtained in hard pieces, requiring grinding, and augment the expenditure of work and time generally.

The difficulty, nay, impossibility, of separating titanium from zirconium is well understood by all analysts who have occupied themselves with the subject. I have not overcome these difficulties, but I hope being able to show my co-laborers a way by which a quantitative estimation of the two metals may be arrived at where they occur together. It was proposed already by the great Nepom. Fuchs to reduce titanium dioxyd or chlorid to the sesquichlorid by tin, and estimate its quantity volumetrically. Owing to the unstable nature of the sesquichlorid and other causes not understood, this method fails to give satisfaction. It is also proposed to effect a separation by boiling the acetate solution of the metals. In my experiments I have not been able to obtain anything like constant results, and the difficulty to remove the alkaline salts from the hydratic oxyds, causes errors in small quantities of the oxyds, amounting to twenty-five per cent.

In my prolonged working with titaninum and the earth of schorlomite, I had occasion to produce the blow-pipe reaction many hundred times, and noticing the various shades of color produced with microcosmic salt in the reducing flame, together with their constancy, I conceived the idea to make this reaction the basis of a quantitative colorimetric method. In the first instance it should be useful in determinative mineralogy to distinguish between the several titanium minerals, where a difference of 10 per cent. even would be sufficient to characterize a species. In working up the idea, however, I was astonished to see how rapidly the eye became sensitive to discriminate between the shades and intensities of color on small surfaces. Thus, when analyzing the astrophyllite, more minute and careful experiments proved that a very satisfactory quantitative estimation of titanium dioxyd may be effected when it is mixed with zirconium or other colorless oxyds, which themselves do not produce a coloration with microcosmic salt in the reducing flame. There are but three metals whose presence in even a comparatively small amount will interfere with the accuracy of this method : vanadium, chromium and tungsten. The two former produce a green salt in the reducing flame, the latter a deep sky blue.

Digitized by Google

I called attention to the effect of vanadium on the titanium reaction some time ago (Proceedings Acad. Nat. Sciences, March, 1876), when it was stated that the two metals, producing complimentary colors – red and green—will extinguish each other; vanadium, however, may be recognized by its deep yellow color in the oxydizing flame, which is most intense at low temperature, while the yellow of titanium only shows at high temperature, just below red heat. This point is not only of general interest, as a case which might possibly present itself to the analyst, but is of direct practical importance, since I have found vanadium in all the titanium minerals of Magnet Cove (Proceedings Acad. Nat. Sciences, March, 1876), and became aware of its existence just by applying this colorimetric method, to the small residues obtained from the iron sesquioxyd, by means of citric acid and ammonium sulphide. Here the titanium had escaped precipitation by boiling, and would have been called alumina, since it formed a nearly white powder and did not give the amethyst red color in the reducing flame. However, vanadium and chromium may be removed from the oxyds by fusion with potassium or sodium nitrate, a treatment which should never be omitted, if the highest degree of accuracy is desired in analysis.

Practical execution of the method. I prepare titanium dioxyd and aluminum sesquioxyd, the former from rutile, the latter from alum, in the finest possible division, by igniting their respective ammonium citrates or tartrates, removing at the same time the last trace of iron by ammonium sulphide. In this fine condition the oxyds are very readily dissolved by the acid sodium phosphate before the blow-pipe. I then weigh out 0.1 gr.; 0.095 gr.; 0.090 gr.; 0.085 gr.........0.005 gr. of each of the oxyds, and mix them together inversely by very careful trituration in the mortar. I produce thus one series containing in

TiO_2	Al_2O_3
100	0
95	5
90	10
85	15
⋮	⋮
0	100

These twenty samples, of one decigramme each, I put in well corked glass tubes with their respective number; they form the standard. 0.002 gr. of the standard mixture, and an equal weight of the unknown mixture are dissolved in equal quantities of microcosmic salt. For very accurate determination it is necessary to weigh the salt (0.12 gr.), but with some experience it is sufficient to form a circular loop on the platinum wire one-eighth of an inch in diameter, then to add gradually of the salt until the bead is nearly spherical, possessing one-eighth-inch thickness. I use a guage for this purpose formed of two pins, whose points are one-eighth

Digitized by Google

inch apart, and between which the bead is made to pass with slight friction. In order to dissolve the entire 2 milligrs., I bring the powder from the scale pan on a square piece of Swedish filter-paper quarter inch square, and place this upon a dark polished surface (bottom of an agate mortar). With the last particles of the oxydes the paper is made to adhere to the bead, burnt and thus no loss is possible. I keep a series of ten beads (from 10–10 per cent.) hermetically sealed in a glass tube for a primary comparison, and having thus established approximately the position in the scale, it is easy to select one directly above and another below, with which to compare. Any person accustomed to make colorimetric observations with liquids will be able to use this method at once, without any special practice. As the reflection from the spherical surface interferes to a certain extent with the adjustment of the color in the scale, I prefer flattening the beads upon a heated steel anvil with a polished hammer, also heated, to prevent a too rapid chilling of the glass.

The thickness of the wire determines the thickness of the glass. I place the several glass plates alongside each other upon a flat porcelain slab, by which means the slightest difference in shade and depth may be recognized. The intensity of color is much greater towards the pure titanium than towards the zero; the blue rays being entirely absorbed by the glass at 25 p. TiO_2, the glass being then purely pink. I am now experimenting upon the feasibility of extinguishing the color of the titanium by a graduated scale of green, representing per cent of titanium, by which means I am led to believe this colorimetric method, before the blow-pipe, will be made easier and more perfect.

2. Arfvedsonite.

Crystallographical properties. The crystals are elongated prisms with the clinopinakoid. As the faces are of equal width the cross section forms an equilateral hexagon. No terminal faces could be observed. The obtuse prismatic angle was found 124° 30′ with the hand goniometer. The habitus is altogether like that of common hornblende. In one large crystal, which I obtained loose, measuring nearly 4 inches in length by one inch in width, I noticed a disaggregation similar to that observed in uralite, that is to say, the crystal breaks up, or crumbles into an infinite number of small individuals. The principal direction of this parting appears to be a plane parallel to the orthopinakoid, a face not developed in the crystal. These small individuals exhibit brilliant faces and give a prismatic angle of 124° 5′ on the reflexion goniometer. On the smaller and more compact crystals, which are imbedded in quartz, I observed a cleavage parallel to the orthopinakoid quite as marked as that parallel to the prism. I could not measure the angle accurately, but it appeared larger than the angle of the prism. The *color* is raven black (after removing superficial impurities by hydrochloric acid), the *lustre* submetallic, and the color of fine powder is lavender blue.

Hardness = 6.

Digitized by Google

Specific gravity = 3.433 at 12 C° (with coarse powder). *Before the blowpipe* melts easily to a black glass in the flame of oil lamp. With microcosmic salt gives the reaction of silica, iron, manganese, and with difficulty that of titanium. Colors the flame yellow. Imperfectly decomposed by fusion with $K\,H\,S\,O_4$, not acted upon by hydrochloric and sulphuric acid at atmospheric pressure, and very slowly decomposed with sulphuric acid in a sealed tube at 160 C°.

Composition :

			Oxygen.		
SiO_2	=	49.83	26.409		
TiO_2	=	1.43	0.558	27.164	5.702
ZrO_2	=	0.75	0.197		
Al_2O_3	=	trace			
Fe_2O_3	=	15.88	4.764	4.764	1.000
FeO	=	17.95	3.983		
MnO	=	1.75	0.383		
Na_2O / LiO	=	8.33	2.149	6.928	1.454
K_2O	=	1.44	0.245		
MgO	=	0.41	0.164		
Ignition	=	0.20			
		97.97			

$\ddot{R} : \dddot{R} : \dot{R} = 17 : 3 : 4.3$

To obtain the atomic ratio, we have :

						Quotient.	Atoms.
Si	= 0.836						
Ti	= 0.017	Si	= 0.0095				
Zr	= 0.006	Si	= 0.0020	Si	=	0.8475	8.56
$\bar{\text{F}}$e	= 0.099			$\bar{\text{F}}$e	=	0.099	1.00
Fe	= 0.249			Fe	=	0.278	2.809
Mn	= 0.025			Na	=	0.286	2.88
Na	= 0.268			O	=	2.428	24.52
K	= 0.031	Na	= 0.018				
Mg	= 0.010	Fe	= 0.004				
O	= 2.428						

and the nearest symbol will be

$$\left.\begin{array}{c} \overset{\text{IV}}{Si_8} \\ \bar{\bar{F}}e_2 \;\; \overset{\text{VI}}{Fe}\cdot Na_3 \end{array}\right\} \overset{\prime\prime}{O}_{24}$$

It is apparent that neither the oxygen ratio, nor the atomic ratio lead to a very satisfactory formula, in as much as the formula given contains one-half atom of oxygen more than required to satisfy the affinities of the metals.

Digitized by Google

Owing to the extreme cleavage of the mineral, a sufficiently thin section could not be prepared to allow a microscopical and optical examination; and the presence or absence of minute particles of other species could therefore not be ascertained. The analysis was conducted with great care, of every constituent a check determination was obtained. Three alkali determinations gave identical results. Only the ferrous iron was but once determined. After being in sealed tube for nearly a week, the mineral was not completely decomposed. After titration I filtered from silica and undecomposed part, removed silica by sodium hydrate, and from the weight of residue I calculated the ferrous iron pro toto. In the face of the duplicate and closely agreeing determinations I cannot explain the deficiency of two per centum in the analysis.

3. Zircon.

Occurs in brilliant, mostly iron black crystals, imbedded in quartz or in astrophyllite. The size varies from microscopic dimensions to ¼ inch pyramidal edge.

Crystallographical properties. The form is a combination P. ∞P. 0P. I observed the basal plane on every crystal which I examined. It is sometimes very small, but mostly very plainly developed and splendent. On one crystal it appeared distinctly rhomboid, and this induced me to measure the angles of the pyramidal edge, which I found 120° 56′; 123° 15′. But all other crystals gave as nearly 123° as the uneven faces could be expected to average. The rhomboidal crystal stands, therefore, alone as a distorted individual. The prism is generally very small, often only a splendent edge.

When boiled with strong hydrochloric acid the black color disappears, and the substance exhibits a yellowish flesh color. The individuals appear corroded. Otherwise, physical characters identical with those of other localities.

Specific gravity at 12 C° = 4.538.

Composition:

SiO_2	=	29.70
ZrO_2	=	60.98
Fe_2O_3	=	9.20
MgO	=	0.30
		100.18

The coarse powder of the mineral had been boiled for some time with strong hydrochloric acid, until no more iron was dissolved. The unusually large percentage of iron still shown by the analysis must reasonably be considered as belonging to the mineral.

Note.—While this paper is in press, I obtained other specimens from El Paso County, in which a black mica occurs in large foliated masses, traversed by astrophyllite. This and another mineral, apparently arfvedsonite changed into a micaceous mineral, I am investigating at present.

Digitized by Google

A measured section of the Palæozoic Rocks of Central Pennsylvania, from the top of the Allegheny River Coal Series, down to the Trenton Limestone in the Lower, or Cambro-Silurian System.

By Charles A. Ashburner,

Asst. 2d Geol. Surv. Pa.

(*Read before the American Philosophical Society, February* 16, 1877.)

The following long section of the Palæozoic strata of Huntingdon County, Pennsylvania, is the result of an instrumental study of a district bounded on the west by Broad Top Mountain; on the north by the East Broad Top Railroad; on the east by Blacklog Valley; on the south by Sideling Hill Creek.

Two vertical sections were constructed along cross section lines, in a north-west direction, from the Trenton limestone of Blacklog Valley to the Broad Top coal basin, a number of other shorter sections were made along selected portions of the district between the two longer lines.

The results of the measurements made on these several lines of survey, sufficiently near together to check one another, are given in the following pages.

The whole height of the vertical section, from the top of the Mahoning sandstone in the Coal Measures down to the bottom of the Trenton limestone, is eighteen thousand three hundred and ninety-four feet (18,394′), distributed as follows:

Carboniferous Strata*......................at least.	3,777′	=18,394′‡
Devonian Strata..................................	7,975′	
Oriskany Sandstone†..............................	58′	
Upper and Middle Silurian.........................	4,214′	
Lower or Cambro-Silurian................at least.	2,370′	

This section would therefore represent the record of a shaft or bore hole 3½ miles deep, sunk from the surface of the land of the Broad Top Coal Basin at Broad Top City.

Carboniferous.

No. XIII.

Alleghany River (Lower Productive) Coal Measures. .... 264′

267. Mahoning Sandstone. A white conglomerate sandstone, containing a softer shaly mass and a coal bed............... 90′

* The base of the carboniferous being in dispute, the term is here made to include the Pocono, Vespertine, or Upper Catskill, X, for reasons evident in the section.

† Geologists may include the Oriskany in the Devonian or in the Silurian as they see proper.

‡ To get this total the measurements of the rocks *above* the Clinton lower olive shale at Saltillo are added to those of the rocks *below* that horizon at Orbisonia.

Digitized by Google

266. Sandstone and shale, *containing a small bed of coal*, in black slate and shale, a short distance below the bottom of the Mahoning Sandstone, probably representing Coal E, Upper Freeport. Lower part, directly above Coal D, hard, rather massive black slate.. 45′

265. Coal bed D, (top bench mine C).............	2′1″	7′9″
264. Black fissile slate containing seams of coal varying in thickness from ¼ to ⅛ inch....................	0′4″	
263. Coal bed D, (middle bench)..................	0′2″	
262. Slate containing a stratum of sandstone about the centre	2′1″	
261. Coal bed D, (bottom bench). Fireclay floor of the mines unmeasured..............................	3′1″	

260. Sandstone and shale; black slate lower part.......... 45∓′

259. Coal bed C, (top bench mine B)..............	1′6″	3′10″
258. Hard grayish-black slate, (varying thickness)...	0′4″	
257. Coal bed C, (bottom bench). Fireclay floor of the mines unmeasured..............................	2′0″	

256. Sandstone, shale and slate.......................... 30′

255. Coal bed B, (top bench mine A).	1′ 6″	4′8″
254. Rock and fireclay.........................	1′ 4″	
253. Coal bed B, (bottom bench).................	1′10″	

252. Sandstone and shale.................................. 35′

251. Coal bed *A*, underlaid by a carbonaceous black fireclay, commonly called black gravel......................... 2′

No. XII

Pottsville (*Seral*) *Conglomerate* (*Millstone Grit.*)............. 280′

Upper Member. *Piedmont Sandstone.*

250. Upper member consisting of three parts, upper white and reddish white and gray flaggy sandstone and conglomerate; in the middle part the conglomerate predominates, the pebbles are larger but irregularly distributed, the strata exhibiting false bedding to a marked degree; while the lower part is composed principally of thinly bedded and conglomeratic sandstone.. 160′

Middle member (*Kanawha River Coal Series*).

249. Sandstone and shale, " " .... 14′

248. Coal (Fireclay floor unmeasured)................. 2′

247. Less massive gray sandstone exhibiting false bedding.. 17′

246. Dark gray and black slate and slaty sandstone........ 7′

Lower member (*Conglomerate proper.*)

245. Hard massive gray sandstone, strata fractured in a perpendicular and also oblique direction to the bedding, surfaces

Digitized by Google

stained and coated with ferric oxide, containing impressions of calamites, lepidodendra leaves and sigillaria.............. 10′

244. Upper part consists of a hard massive gray and white sandstone and conglomerate, the latter predominating toward the central part where the pebbles are large; while in the lower part there is less conglomerate, the sandstone becoming dark gray and flaggy, containing micaceous specks........... 70′

No. XI.

Mauch Chunk (Umbral) Red Shale................ 1100′

Upper Member.

243. Brown silicious and shaly hematite, varying thickness.
242. Yellow argillaceous sand shale 5 ± feet..............
241. Yellow and greenish-yellow flaggy sandstone with slight alternations of green argillaceous shale 20 ± feet....
240. Red and gray sandstones, and shales, rather flaggy and argillaceous .... } 150′

[At the west end of Wray's Hill Tunnel.]

239. Very soft bright red shale............................ 59′
238. Hard grayish-red sandstone showing false bedding... 41′
237. Red sandstone containing white calcareous seams along planes of false bedding.................................. 48′
236. Softer red sandstone.............................. 28′
235. Dark grayish-red sandstone, much harder and exhibiting false bedding and perpendicular fracture...... .... 14′
234. Friable soft bright red sandstone and shale.......... 93′

[At the east end of Wray's Hill Tunnel.]

233. Partly concealed. Probably composed of red and gray sandstone with alternations of red and gray shales and flags.. 300′
232. Probably red shales and sandstone.................. 177′

Middle member (*Mountain Limestone.*)

231. Red shaly limestone .... 3 ±′
230. Red shale very argillaceous........................ 10 ∓′
229. Soft argillaceous red shale.......................... 5′
228. Massive silicious red limestone (easily weathered) containing *Terabratula Ræmingeri, Grammysia, Strophodonta, Rhynchonella*.. 2′6″
227. Very soft red shale................................ 2′
226. Red and gray mottled, calcareous shale (concretionary) contains *Centronella* .... 3′
225. Red calcareous shale and limestone.................. 9′
224. Variegated red and gray massive limestone.......... 1′
223. Gray massive limestone............................ 3′
222. Red shale... 6′
221. Greenish-gray argillaceous limestone................ 4′

Digitized by Google

Lower member.

220. Concealed.. 3′

219. Partly concealed. Probably composed of massive red silicious sandstone and shale with alternations of gray sandstone and flags.. 114′

218. Coarse grained greenish-gray sandstone overlaid by red shale.. 3′

217. Heavy argillaceous gray sand shale, conchoidal fracture containing streaks of hematite and manganese.......... 7′

216. Reddish-gray, sandy slate colored with ferric oxide.... 3′

215. Very hard, flinty greenish-gray, massive sandstone... 7′

214. Alternating brittle green and red shale.............. 2′

213. Hard, dark-gray sandy slate........................ 2′

No. X.

Pocono (*Vespertine*) *Gray Sandstone*................ 2123′

Upper member.

212. Partly concealed. Composed for the most part of hard, coarse grained, massive, brownish-gray and gray sandstone, alternating with thinly bedded and flaggy sandstone, and shale of the same color. Near the top a few beds of red shale and sandstone.. 580′

[At the west end of Sideling Hill tunnel.]

211. Massive gray sandstone surfaces coated with ferric oxide.. 8′

210. Alternating massive gray and greenish-gray sandstone containing a twelve inch seam of black slate showing impressions of minute plants................................ 22′

Middle member, upper part.

(*New River Coal Series*).

209. Massive gray sandstone containing thin partings of coal. 29′

208. Gray argillaceous sand............................ 5″

207. Coal (seam No. 19)............................ 2½″

206. Soft greenish-gray micaceous shale.................. 1′3″

205. Light gray, massive sandstone containing thin plates of coal and micaceous specks................................ 56′

204. Sandstone containing thin partings of coal............ 1′

203. Soft, loose sandstone containing seams of coal, running irregularly through the mass, amounting in all to about 5 inches.. 6′

202. Massive sandstone containing in its lower part plates of coal.. 12′

201. Poor, bony coal (Seam No. 18)...................... 2″

200. Sandstone.. 1′6″

199. Argillaceous sand............................ ½″

198. Coal (Seam No. 17), maximum thickness 9 inches.... 3″

Digitized by Google

197.	Argillaceous sand containing plates of coal	4″
196.	Gray sandstone containing between the strata a great deal of loose sand	15′
195.	Gray sandstone containing nodules of pyrites and plates of coal in the upper portion of the mass	26′
194.	Coal very much broken up. (Seam No. 16)	1″
193.	Sandstone containing nodules of iron pyrites	2′6″
192.	Coal (Seam No. 15); brilliant lustre, rhombohedral fracture, resembling bituminous coal	1″
191.	Sandy fireclay	6″
190.	Coal (Seam No. 14)	1″
189.	Sandstone with thin partings of coal in the lower portion.	4′
188.	Sandstone	9′
187.	Fireclay	1″
186.	Shaly sandstone	34′
185.	Coal (Seam No. 13)	1″
184.	Alternating shaly and massive, gray sandstone	6′
183.	Poor bony coal (Seam No. 12)	3″
182.	Shaly sandstone	6′
181.	Coal (Seam No. 11); very much broken up and associated with red sand	1″
180.	Shaly sandstone	4′
179.	Coal (Seam No. 10) maximum thickness 6 inches	3″
178.	Shaly sandstone	2′
177.	Coal (Seam No. 9)	1″
176.	Shaly sandstone	1′
175.	Coal with sandstone above and below (Seam No. 8)	1″
174.	Gray sandstone	36′
173.	Steel gray shale of a greasy lustre	8″
172.	Coal (Seam No. 7)	1″
171.	Fire clay	1″
170.	Sandstone	5′
169.	Coal (Seam No. 6)	1″
168.	Sandstone	10″
167.	Coal (Seam No. 5) resembling very much specimens from Montgomery County, Virginia	2″
166.	Soft sandstone	5″
165.	Coal (Seam No. 4)	2″
164.	Sandstone containing loose brown, argillaceous sand	14′
163.	Loose sand shale, surfaces coated with acicular crystals of sulphate of alumina formed by the decomposition of pyrites	3′
162.	Coal; very much broken up by false bedding and containing a great deal of iron pyrites (Seam No. 3)	2″
161.	Massive, gray sandstone having a rhombohedral fracture and containing specks of slate and ferruginous matter	28′

Digitized by Google

160. Coal (Seam No. 2); very much broken up by false bedding........ 1″
159. Soft, gray, shaly sandstone exhibiting false bedding.. 5′
158. Poor bony coal (Seam No. 1)........ 1″

Middle member. Lower part.

157. Soft, black shale containing plates of coal and impressions of minute plants, surfaces stained with ferric oxide; alternating with a fine grained conglomerate containing micaceous specks........ 25′
156. Yellowish-gray, argillaceous shale containing thin plates of coal. Surfaces showing "slicken sides."........ 26′
155. Sandstone........ 9′
154. Black, carbonaceous slate enclosed in hard massive sandstone........ 2″
153. Hard, massive, gray sandstone........ 17′
152. Hard, conglomeritic, light gray sandstone containing a few alternations of black slate........ 51′
151. Hard, massive sandstone alternating with gray slaty micaceous sandstone........ 45′
150. Soft, gray shale........ 1′
149. Alternating dark gray, flaggy and slaty sandstone containing micaceous scales........ 33′
148. Dark gray, argillaceous shale with talcy lustre........ 39′
147. Dark greenish-gray shale, with talcy lustre, containing acicular crystals of sulphate of alumina formed by the decomposition of pyrites........ 10″
146. Soft, black slate........ 3″
145. Massive, gray sandstone........ 3′
144. Soft, gray, argillaceous shale........ 5′6″
143. Massive, hard gray sandstone........ 25′
142. Fine grained, light gray conglomerate alternating with thin strata of black micaceous sandstone........ 13′
141. Fine grained, dark gray, argillaceous shale alternating with a hard, gray sandstone interstratified with a black micaceous sandstone........ 26′
140. Massive, flinty gray sandstone alternating with yellowish-gray sandstone showing false bedding........ 17′
139. Soft, gray shale........ 1′3″
138. Hard, gray sandstone........ 1′6″
137. Soft, gray shale........ 1′6″
136. Soft, yellowish gray shale of a talcy lustre........ 1′6″
135. Very hard, massive bluish-gray sandstone, with occasional seams of a lead-colored clay........ 4′
134. Hard, massive gray sandstone........ 13′
133. Gray slaty sandstone........ 10″
132. Carbonaceous shale........ 5″

Digitized by Google

131. Gray shale.. 3″
130. Black coal slate.. 2″
129. Gray sand shale.. 3′4″
128. Black slate.. 4″
127. Hard, massive gray sandstone alternating with yellowish gray, argillaceous sand shales.. 15′

Lower Member.

126. Dark bluish-gray slaty sandstone alternating with a shale of close texture.. 22′
125. Alternating gray, green and yellow shale............ 25′
124. Green shale containing *Cypricardina* and *Orthis*. ... 5′

[At the East end of Sideling Hill Tunnel.]

123. Partly concealed. Alternating as above but softer.... 25′
122. Hard, coarse-grained reddish-gray sandstone alternating with soft, yellow sandy shale.. 165′
121. Coarse-grained yellow sandstone. Surfaces stained with iron, alternating with grayish-brown sandstone .... 12′
120. Alternating yellow, gray and green shaly sandstone.. 44′
119. Soft yellow, sandy shale interstratified with a gray flaggy sandstone, alternating with a brown sandstone containing micaceous specks.. 50′
118. Flaggy olive sandstone alternating with a greenish-gray sandstone containing iron concretions. Partly concealed.. 42′
117. Partly concealed. Soft green and olive sandstone alternating with soft, yellow, flaggy and hard, massive gray sandstone containing ferruginous specks and having a distinct rhombohedral fracture.. 440′

DEVONIAN.

No IX.

Catskill (Ponent) Red Sandstone.................. 2680′

116. Concealed. Probably composed of red shales and sandstone alternating with white and gray sandstones.........175′
115. Greenish-gray, slaty sandstone containing micaceous specks alternating with soft, bright red shale................ 100′
114. Massive, coarse-grained, reddish-gray sandstone alternating with red shale and sandstone........................ 125′
113. Very silicious brown hematite, thickness undetermined, but variable.. —
112. Partly concealed. Consisting for the most part of red flaggy sandstone and shale alternating with massive yellow, gray and white shaly sandstone..........................1520′
111. Red, sandy and argillaceous shale; lower part contain-

Digitized by Google

ing fucoid stems and showing a fine exhibition of ripple marks... 270′

110. Red, massive sandstone and shale with slight alternations of green sandy shale and massive brown sandstone, particularly toward the lower part.......................... 140′

109. Red shale and sandstone alternating with gray shale and massive gray sandstone; containing small deposits of coal. 290′

108. Light yellow, sandy shale alternating with friable red shale; surfaces stained with bituminous matter. Lower part brownish-gray sandstone containing micaceous specks...... 60′

Transition Strata between IX and VIII................ 90′

107. Yellowish-white, argillaceous sand shale lower part containing lepidodendra and calamites.................. 8′

106. Red sandstone and shale, containing ripple marks, with slight alternations of green shale..................... 18′

105. Alternating olive-green sandstone and shale, lower part of a darker green color.................................. 10′

104. Greenish-gray sandstone and shale; upper 10 feet containing quartz crystals; lower part fossiliferous............ 15′

103. Alternating red sandstone and shale................. 25′

102. Green fissile shale.................................. 1′

101. "Larry's Cr. ore bed," ranging from 4 inches to 1 foot thick, containing *Spirifer disjuncta* and *Rhynchonella*....... 8″

100. Green fissile shale containing two sandstone strata, 2 inches thick, upper surfaces showing ripple marks and under surfaces containing impressions of fucoid stems............. 3′

99. Fossiliferous, brownish-gray sandstone containing *Spirifer disjuncta*, &c.. 1′

98. Dirty white sand shale containing plant impressions.... 3″

97. Yellowish-red sandstone............................ 5′

96. Red shale, easily weathered, containing occasional seams of sandstone and green shale a few inches thick....... 3′ +

No. VIII.

Chemung (Vergent) Shales.................... 1860′

95. Partly concealed. Consisting, for the most part, of olive and brown argillaceous sandstone and shale, containing alternations of red fissile shale. Readily weathered into clay.... 245′

94. Massive dark-gray sandstone containing ferruginous specks alternating with reddish-gray, flaggy sandstone....... 15′

93. Upper part fossiliferous greenish gray sandstone; lower part alternating soft red and light green sandy shale......... 100′

92. Massive brown sandstone. Surfaces stained with iron and coated with minute quartz crystals, alternating with light red shale, showing impressions of fucoids.................. 70′

Digitized by Google

91. Red, brown and gray sandstone. The lower part is composed principally of red and olive sand shale containing micaceous specks; surfaces of the olive shale very much stained with iron.. 140′

90. Partly concealed. Consisting for the most part of hard, massive, gray and brown sandstone, containing micaceous specks, alternating with softer shaly strata.................. 500′

89. Partly concealed. Composed principally of massive, gray and brown sandstone, containing yellow and red specks, alternating with softer sandstone and shale; the softer strata predominating more than in No. 90, being marked by sharp narrow ravines running parallel with the strike............. 490′

88. Brown, green and gray massive and flaggy sandstone; surfaces very much stained with iron. .... 80′

87. Partly concealed. Consisting for the most part of red and olive shale and sandstone; former predominating........ 100′

86. Massive reddish-brown sandstone containing micaceous specks.. 10′

85. Massive reddish-brown sandstone, containing micaceous specks, and shale alternating with brown argillaceous sandstone containing crinoid stems............................ 110′

Portage (Vergent) Flags...................... 1450′

84. Partly concealed. Consisting for the most part of hard, massive brown and gray sandstone with alternating strata, from 10′ to 30′ thick, of soft olive and gray shale, marked in some cases by sharp narrow ravines running parallel to the strike...................................... 500′

83. Massive brown sandstone, containing iron specks, alternating with shale.. 40′ ±

82. Light fawn colored, argillaceous shale alternating with greenish yellow, flaggy sandstone; surfaces coated with minute quartz crystals.. 70′

81. Partly concealed. Composed principally of yellow, green and light olive shale alternating with occasional seams of brown and gray sandstone............................ 140′

80. Light fawn colored, yellow and green argillaceous shale alternating with soft olive brown and green flaggy sandstone; latter containing yellow and red specks and surfaces stained with iron.. 100′

79. Light olive shale with yellow and red stains, lower part very fissile.. 80′

78. Yellow shale containing a few alternating seams of sandstone.. 80′

77. Dark olive and yellow argillaceous shale.............. 120′

76. Light olive shale containing alternations of thinly laminated sandstone strata, from 1 to 2 inches thick.......... 100′

Digitized by Google

75. Same in character as No. 76, but with the sandstone predominating.. 60′
74. Dark olive shale containing seams of shaly sandstone, stained bright red with ferruginous matter.................. 50′
73. Olive, red and yellow shale.......................... 10′
72. Gray sandstone with a few alternating beds of olive shale. 35′
71. Fine grained, greenish-gray sandstone, in seams from 4 to 6 inches thick, alternating with fine-grained, olive fissile slate.. 65′

Genesee (Cadent Upper) Slate.................... 325′

70. Partly concealed. Olive slaty and shaly sandstone alternating with brownish gray, flaggy sandstone and a few beds of olive shale.. 100′
69. Light olive and greenish-gray argillaceous shale and slate.. 75′
68. Partly concealed. Probably same in character as No. 69.. 100′
67. Dark olive, fissile slate with occasional seams of a bright brown-colored sandstone, 2 to 4 inches thick................ 50′

Hamilton (Cadent) Shales...................... 635′

66. Partly concealed. Consisting for the most part of gray sandstone flags and shales containing fossils as in No. 65, but not as abundant.. 250′
65. Upper part, hard, massive greenish-gray and flaggy olive sandstone, lower part light, olive, slaty sandstone. Surfaces very much stained with iron. Contains: *Aviculopecten princeps*, *Chonetes mucronatus* and *coronata*, *Grammysia*, *Spirifer granulifera* and *mucronatus*, and *Tentaculites*. *Algæ* more particularly Spirophyton *caudagalli*....................... 85′
64. Partly concealed. Consisting for the most part of massive, gray and flaggy sandstone alternating with beds of thinly laminated, fissile shale (fossiliferous)................. 200′
63. Thin, gray, calcareous, flaggy sandstone, and seams of greenish-gray, fragile sandstone alternating with gray and dark olive shale.. 100′

Marcellus (Cadent Lower) Black Slate................ 875′

62. Partly concealed. Composed principally of gray and brown shale alternating with flaggy and slightly calcareous sandstone.. 200′
61. Argillaceous gray, olive and brown shale very much stained with iron and bituminous matter................... 200′
60. Partly concealed. Consisting for the most part of brown, gray and black argillaceous shale with occasional seams of sandstone....... .... 171′

Digitized by Google

59. Gray, shaly, argillaceous limestone alternating with greenish-gray lime-shale (local deposit?).................... 20′

58. Black fissile slate and shale, surfaces very much stained with iron and coated with bituminous matter................ 100′

57. Black slate and brown shale, surfaces stained with iron and coated with bituminous matter; the shale in the lower part directly above the iron ore bed is very argillaceous...... 180′

56. Marcellus iron ore bed, varying thickness............. 4′

Upper Helderberg (Post Meridian) Limestone .... 60′

55. Dark blue limestone containing seams of calcite........ 4′

54. Dark brownish-gray argillaceous lime shale........... 2′

53. Dark blue argillaceous limestone....... .... 2′

52. Dark bluish-gray lime shale and light olive calcareous shale.. 7′

51. Dark greenish-gray lime shale........................ 1′

50. Concealed. Shaly limestone (?) .... 7′

49. Dark olive calcareous shale easily weathered.......... 22′

48. Massive gray argillaceous limestone.................. 5′

47. Fragile dark olive and yellow argillaceous limestone... 10′

46. *Schoharie* and *Caudagalli*, both wanting, but perhaps represented by clay and shale on top of the Oriskany.

No. VII.

Oriskany (Meridian) Sandstone..................... 58′

45. Upper part ocherous clay, lower part coarse-grained ferruginous and calcareous sandstone......................... 12′

44. Friable sand containing pebbles size of a pea.......... 15′

43. Coarse-grained arenaceous sandstone more fragile than above and breaks into more irregular shapes. Mass stained with ferruginous matter and surfaces coated with red hematite. Contains: *Cyrtoceras expansus, Dalmania micrurus, Eatonia peculiaris, Megambonia lamellosa, Orthis hipparionyx, Platyceras ventricosa, Pterinea texilis, Rensselaeria marylandica, Rensselaeria ovalis, Rensselaeria ovoides, Spirifer arenosus, Spirifer arrectus.* Oriskany hermatite ore bed, locally deposited at the lower horizon.............................. 31′

Silurian.

No. VI.

Lower Helderberg.

Lewistown (Pre-meridian) Limestone................. 162′

42. Partly concealed. Upper part composed principally of shaly, argillaceous limestone with probably a few beds of crys-

Digitized by Google

talline limestone, while the lower part is made up principally of the latter. .... 30′

41. Massive, dark blue, crystalline limestone.............. 42′

40. Massive, bluish-gray limestone, parts of which are characterized by a conchoidal fracture...................... 20′

39. Massive, brownish-gray, and blue, crystalline limestone containing alternating beds of gray shale limestone........... 20′

38. Massive, gray, crystalline and dark blue, argillaceous limestone with occasional beds of light gray, shaly limestone and lime shale. Contains: *Acervularia, Alveolites minima, Alveolites, Astylospongia inornata, Merista lævis, Orthis oblata, Pentamerus galeatus, Rhynchonella formosa, Astylospongia, Atrypa reticularis, Aulopora, Conophyllum, Merista arcuata, Stromatopora, Trematospira formosa, Zaphrentis*............ 50′

Water-lime (Scalent) Cement Beds.................. 580′

37. Partly concealed. Consisting for the most part of blue and gray, thinly laminated, argillaceous limestone........... 150′

36. More massive, bluish-gray, argillaceous limestone thinly laminated. The massive strata have a conchoidal fracture... 110′

35. Massive, dark gray and bluish-gray limestone, surfaces coated with carbonaceous matter and showing "slicken sides." Also contains calcite with a marked cleavage. Lower part contains impressions of fucoids and bivalve shells.......... 30′

.34. Partly concealed. Similar to No. 35 but containing lime shale.. 90′

33. Massive bluish-gray limestone alternating with slaty argillaceous limestone and green and yellow calcareous shale. 50′

32. Partly concealed. Principally yellow and gray, argillaceous lime shale..................................... 60′

31. Gray and bluish-gray, slaty, argillaceous limestone and shale... 20′

30. Thinly laminated, blue and yellow argillaceous limestone alternating with gray lime shale..................... 20′

29. Brownish-gray and gray, slaty limestone containing seams of calcite.. 30′

28. Bluish-gray slaty limestone and lime shale............ 20′

Onondaga (Salina) (Scalent) Marls............... 440′

27. Yellow, brown, gray and green, argillaceous and calcareous shale... 20′

26. Partly concealed. Composed principally of olive and gray calcareous shale.................................. 50′

25. Gray, shaly limestone alternating with olive, calcareous shale... 100′

24. Partly concealed. Composed for the most part of yellow

Digitized by Google

and green, calcareous shale alternating with red, argillaceous shale... 70′

23. Partly concealed. Composed for the most part of green, yellow and gray, calcareous shale alternating with red shale.. 150′

22. Olive and gray, calcareous shales with a few alternating beds of red shale... 50′

No. V.

Clinton (Surgent) Red Shale... ..1145′

21. Red, sandy shale containing irregular deposits of green shale. The red shale is more silicious and massive toward the upper part, where it exhibits a rhombohedral fracture...... 120

20. Partly concealed. Probably composed of red, argillaceous shale containing alternations of green and gray, calcareous shale... 100′

19. Red, shaly sandstone containing irregular seams of calcite, becoming argillaceous toward the bottom... 50′

Clinton upper Olive Shale... 162′

18. Gray, olive and yellow, calcareous shale containing seams of blue, fossiliferous limestone... 30′

17. Olive and olive-brown, argillaceous and calcareous shale containing seams of blue, fossiliferous limestone... 80′

16. Similar to No. 17, but containing more seams of limestone toward the bottom... 40′

15. Blue and gray, argillaceous limestone alternating with dark olive shale ; lower part composed of light yellow, argillaceous lime shale, forming the hanging wall of the fossil ore bed. The Clinton upper olive shale contains the following fossils, more particularly in the lower part : *Atrypa reticularis, Beyrichia lata, Buthotrephis gracilis, Dalmania limulurus, Homalonotus delphinocephalus, Orthis elegantula, Platyostoma niagarensis, Pterinia emacerata, Rhynchonella neglecta, Strophomena rhomboidalis*... 12′

Clinton Ore Rocks... 53′

14. Upper fossil ore bed...	10″	3′
13. Red sandstone and white shale...	12″	
12. Lower ore bed...	14″	

These are asserted to be safe average thicknesses of these three beds, by H. G. H. Tarr, Superintendent of Rock Hill Iron and Coal Co. at Orbisonia.

11. *Ore Sandstone.* Its upper part is composed of massive, yellow sandstone under ore bed at Rockhill, while at Saltillo the upper part is very calcareous. The central part is composed of yellow and green, fossiliferous sandstone (crinoid stems) alternating with shale, while the lower part becomes much more massive... 50′

Digitized by Google

Clinton lower olive shale........................ 660′

10. Yellow, gray and green, argillaceous shale weathering olive and claret color, near the lower part the surfaces of the shale are stained with iron and bituminous matter.. 600′

9. Same as No. 10. Lower part containing soft olive shale, showing impressions of crinoid stems (Three Springs), and red shale (Rockhill), containing by analysis 4.29 per cent. of metallic iron.. 60′

No. IV.

Medina (Levant) Sandstone.................... 1330′

8. Massive, white and light gray, fine-grained, hard sandstone alternating near its upper limit with beds of red and greenish shale. Contains *Arthrophycus harlani*............ 400′

7. Soft, argillaceous brown and red sandstone and shale, the sandstone in the central part softer, and more friable and contains specks of ferruginous matter.......... .. .. 930′

Oneida (Levant) Sandstone...................... 568′

6. Red and greenish gray, silicious breccia and conglomerate. 158′

5. Hard, massive, greenish sandstone and gray conglomerate. 410′

No. III.

Hudson River (Matinal) Shale................... 1870

4. Brown and bluish-gray shales and sandy slates, containing especially in upper part beds of argillaceous sandstone. A reddish-gray shale in upper portion contains crinoid stems... 800′ ±

Utica (Matinal) Slates.

3. Brown, brownish-gray and black fissile slate, parts very carbonaceous, toward lower part becomes slightly calcareous. 1070′ ∓

No. II.

Trenton (Matinal) Limestone.

2. Dark blue and bluish-gray, soft, argillaceous limestone, alternating with blue, calcareous shale particularly toward its upper limit.. 500′ (?)

Calciferous (Auroral) Magnesian Limestone.

1. Massive, light-bluish-gray, magnesian limestone. Upper part only exposed, lower horizon below surface of erosion.... ——

No. I.

Potsdam Sandstone below the present surface.

Digitized by Google

NOTES *to explain the above Section.*

The Section, although a continuous one of Carboniferous, Devonian and Silurian strata, is subdivided into groups which represent the long since recognized and generally accepted formations of the State Geological Reports of New Jersey, Pennsylvania and New York.

The original numbering of these formations from I to XIII is the oldest attempt at a subdivision of the Palæozoic system, having been made in 1836. The numbers were used as a provisional nomenclature in publishing the Annual Reports of the First Survey of Pennsylvania. They have been used more or less in all subsequent surveys by geologists. They are retained in this section as convenient symbols for ready reference, although they have lost much of their lithological and still more of their palæontological value.

The geographical nomenclature of the New York Final Reports of 1843 and 1844, as well as the more poetical names afterwards adopted by Professor Rogers for his Geology of Pennsylvania, published in 1858, are given with the numbers, although the formations to which they have been assigned do not in all cases exactly correspond as to their upper and lower limits.

Some new names will also be noticed, chiefly near the top of the section. *Pottsville Conglomerate, Mauch Chunk Red Shale* and *Pocono Sandstone* are geographical synonyms for XII, XI and X,—or for *Seral, Umbral* and *Vespertine,*—proposed by the present State Geologist, to fill the gap at present existing in the *geographical nomenclature* of the Palæozoic rocks between the Catskill Formation and the Alleghany River Coal Measures. As IX and X together make up the mass of the Catskill Mountains, yet have always been regarded as separate formations, and as there is a geological objection to distinguishing them as Lower and Upper Catskill, the fact that X constitutes the mass of the Pocono Mountains in Pennsylvania, has been taken advantage of to provide it with an analogous geographical and euphonious name.

Mauch Chunk and Pottsville, where XI and XII have their maximum development, are important and well-known places, and there seems to be no valid objection to applying these names to those formations.

Much lower down in the Section a subdivision of the Lower Helderberg group, a limestone formation of unusual thickness, is named from the borough of Lewistown, one of the most important places on the Juniata River, where this limestone attains its maximum of size. A special name for the limestoue is called for, because it cannot yet be certainly identified with any special one member of the Lower Helderberg Series.

As to the thicknesses assigned to the divisions and subdivisions of the Section, it must be understood that they were obtained partly by direct

Digitized by Google

measurement of single outcrops, or series of outcrops,—partly by geometrical construction of a vertical section along one line, and by means of occasional, but neighboring outcrops,—and partly by construction on one or more lines of observation.

The planes or horizons between the groups and formations of the Section are in some cases arbitrarily assumed, being based exclusively neither upon lithological nor palæontological grounds, as the descriptive text of the section shows. In a number of instances the division or subdivision line has been necessarily drawn at the end of an exposure, or at a sudden break in, or change of, the topography.

The section must therefore be taken only for what it is worth, but by no means as a complete, authorative or final statement of the constitution of the Palæozoic system in Middle Pennsylvania. Many of its lacunæ will no doubt be filled up by future explorers, and some of its zero points shifted the better to agree with the true succession of deposits.

No. XIII. Alleghany River (Lower Productive) Coal Measures.

The Mahoniny Sandstone at the top of the Section has commonly been considered the base rock of the Barren Measures, or Lower Barren Measures, of the great Bituminous Coal Field of Western Pennsylvania. But as it may with equal propriety be accounted the top rock of the Lower Productive Coal System (being in fact known as "The Top Rock" on Broad Top), and as the Alleghany River Coal Series must be taken (as Mr. Platt's report on Somerset Co. will show) to include the entire 800 feet of Coal Measures from the Pittsburgh Coal Bed down to the Pottsville Conglomerate (or even lower still), no mention of Barren Measures has been made in this Section.

The Mahoning Sandstone, No. 267 of the section, caps the hill to the north-west of Robertsdale in the East Broad Top or Trough Creek Coal Basin, where the top of the section ends. It is given a thickness of 90 feet; a portion of it may have been eroded from the surface of the hill.

The coal measures beneath it (Nos. 266 to 251 inclusive,) are 174 feet thick and consist of shales, slates and sandstones, containing 3 workable seams of coal (2 benches each). On account of a number of rolls in the strata and the varying dip of the rocks at Robertsdale, where the coals have been most extensively developed, and for the want of a system of levels throughout the workings on the coal seams, it was impossible, with any degree of certainty, to determine the precise intervals between the several coal beds. The given thicknesses between the coals are only approximate, and may be found to vary as much as 10 feet, although the total thickness of the series is probably as fair an estimate as can be made. If the classification which is proposed for the coal seams shall be verified by actual development, it gives us a means of comparison with the Alleghany series in Western Pennsylvania.

Digitized by Google

XII. *Pottsville (Seral) Conglomerate, (Millstone Grit).*

Upper member	(Piedmont sandstone) No. 250...............	160′	280′
Middle "	(Kanawha River series), Nos. 249, 48, 47, 46..	40′	
Lower "	(No. XII proper) Nos. 245 and 244...........	80′	

1. *The Upper member*, or (Piedmont sandstone) consists of three parts: upper white and reddish-white and gray, flaggy sandstone and conglomerate; in the middle part the conglomerate predominates, the pebbles here being the largest, but very irregularly distributed, while the strata themselves exhibit false bedding in a marked degree. The lower part of this member is composed, principally, of thinly bedded and conglomeritic sandstone.

The beds of conglomerate do not seem to be persistent. It would appear as if a bed, in force in one locality, feathers out from a centre of maximum thickness in all directions and disappears entirely, while an upper or lower conglomerate bed has its minimum thickness at the very locality where the other is at its thickest.

Dr. Newberry, in Vol. II, Geology of Ohio, p. 107, suggests the origin of the conglomerate in No. XII as being due to icebergs. He says, "From the similarity of the deposits now being made by icebergs, over various portions of the sea bottom, with those made by the same agency during the Drift Period, and of both to the materials composing the carboniferous conglomerate, I have suggested the possibility that they might all be products of the same agency. In this view the conglomerate should be compared with the kames and eskers of the drift. This theory, however, is not insisted upon, but is simply a suggestion, which has sprung from a conviction of the entire inadequacy of any other solution of the problem yet offered."

2. *The middle member*, or Kanawha River Coal Series, so named from its great development along the Kanawha River, in West Virginia, consists of sandstones and shales containing a seam of coal, No. 248, about 2 feet thick, which represents undoubtedly the Mount Savage coal bed. This set of beds resembles strongly in general character the rocks of the lower productive coal measures.

The coal bed No. 248 is overlaid by sandstone and shale No. 249, and underlaid by massive gray sandstone No. 247, exhibiting false bedding, with probably a bed of fireclay between the sandstone and coal. The seam was located in many places on Wray's Hill and Rocky Ridge, but there was only one locality (Rocky Ridge, west end of Wray's Hill tunnel) where its thickness could be determined and it was impossible on account of water in the opening to ascertain the exact nature of the underlying stratum.

No. 246 at the bottom of the middle member is 7 feet thick and (17 feet below the coal seam) is composed of dark gray and black slate and slaty sandstone; the slate predominating. A small seam of coal was reported to have been found in the black slate, but it is a little doubtful, as no traces

Digitized by Google

of its existence could be found, although some parts of the slate itself seem to be slightly carbonaceous. The whole member is quite argillaceous and contains a great deal of oxide of iron, which, on weathering, renders the surfaces of the strata of a dull brown color.

3. *The lower member*, or Conglomerate proper is for the upper ten feet composed of (No. 245) hard, massive, gray sandstone; the surfaces are very much coated with iron, and the layers contain a great many floral impressions (lepidodendra, calamites and sigillaria).

The remaining 70 feet of this member consists (in the upper part) of a hard, massive, gray and white sandstone and conglomerate, the latter predominating toward the central part, where the pebbles are larger. In the lower part there is less conglomerate, the sandstone becoming dark gray and flaggy and containing micaceous specks.

A careful study of the section reveals some very sharp horizons between sandstone, shale and slate, and coal and sandstone, conveying the idea of sudden and great changes of the conditions attending the deposit.

In Clinton county, in north central Pennsylvania, I have measured the conglomerate (probably lower member) and found it only 25 feet thick. To the south-west of Broad Top the series expands very rapidly, the expansion taking place in the middle member. At Pottsville No. XII is 1030′ thick.

On the Kanawha River, in Raleigh Co. West Virginia, Prof. W. M. Fontaine reports the following section (Silliman's Journal, April, 1876):

Upper conglomerate 150 to 200 feet thick.

Kanawha coal series (Fontaine's New River Series), composed of sandstones, shales and slates, containing nine seams of coal, whose aggregate thickness is 20 feet. The coals occur in the centre and toward the top of the series. Thickness 967 feet.

Lower conglomerate, thickness 80 feet.

The thickness of the upper and lower members at Broad Top and on the Kanawha River is the same, while the middle (coal-bearing strata) on the Kanawha is 24 times thicker than the same series at Broad Top.

A number of years ago Prof. Lesley reported on two workable beds of coal in Montgomery county, Virginia, and his discovery of more than a dozen coal beds along the western flank of Peak Mountain in Wythe County, in No. X. and named the coal series after the New River. This name, takes precedency of Prof. Fontaine's name of New River, applied in recent publications, to the Conglomerate coal series, of No. XII which Mr. Lesley therefore proposes to call the Kanawha River series.

No. XI. *Mauch Chunk* (*Umbral*) *red shale.*

Upper member	(shales and sandstones) 243 to 232............	910′	1100′
Middle "	(mountain limestone) 231 to 221..............	49′	
Lower "	(shales and sandstones) 220 to 213............	141′	

1. *The upper member* is made up of red shales and sandstones, with alternations of gray, flaggy sandstone and shale. Its upper limit is well-defined by a gray mottled carbonate of iron, No 243, which, along its out-crop has

Digitized by Google

been oxidized by the action of the atmosphere, and is changed from a proto-carbonate of iron into a brown peroxide.

In many places on Wray's Hill in Todd and Carbon Townships, the blossom of the ore bed, along its outcrop, is a silicious and shaly brown hematite, and on Iron Knob, directly to the south of Wray's Hill tunnel, loose fragments of the ore were found as a very silicious brown hematite associated with and containing pieces of red and green shale.

The lower limit of this upper member is placed on the red, shaly limestone of the middle member. The three-fold character of the upper member, which Professor William B. Rogers mentions as being everywhere discernible in Virginia, is to some extent to be noticed here, for we have the upper 209 feet formed of variegated and alternating red and gray sandstones and shale; directly below this 524 feet of harder strata composed principally of gray and red sandstones, flags and shale, the upper part exhibiting false bedding; while the 177 feet immediately above the limestone are made up of red shales and sandstones, the former predominating. We then have the following sub-divisions of this upper member:—*a*, from Nos. 243 to 239 inclusive;—*b*, from 238 to 233;—*c*, 232.

The No. 242 seems to be a persistent associate of the overlying ore bed, it is extremely argillaceous and at times seems to be formed of clay. Small specks of carbonaceous matter were found scattered through the mass on the southeast flank of Wray's Hill near the road crossing to Cook's station.

No. 241 is, probably, more variable in character than 242. In some localities it seems to change into, or be replaced by, red shale, not being distinguishable from 240.

No. 240 and 239 are more like argillaceous marlites, easily weathering, and producing a deep red soil.

On account of the very imperfect exposure of this part of No. XI, the section may not reveal the minuter and more important alternations of the strata which doubtless exist.

Professor Rogers (Final Report, Vol. I, p. 531) says, "These strata become more silicious as they approach the Conglomerate, and in the form of green, buff and hard reddish argillaceous sandstones embrace impure calcareous beds." The relative position of these beds will appear from the following observations made on the west flank of Broad Top Mountain, half a mile below Riddlesburg.

(17.) No. XII, seral conglomerate not 100 feet thick, the lowest coal bed above it being only about 100 feet above the limestone No. 14.

(16.) Interval of a few feet unknown.

(15.) Silicious slate, dull brown color, 10 feet.

(14.) Limestone, hard, silicious, reddish, embracing plates of red shale; its fragments strew a blank space of 40 feet, occupied probably by red shale below its apparent outcrop.

(13.) Sandstone, fine-grained, micaceous, green, passing downwards into olive shale, 20 feet.

(12.) Sandstone, gray, 3 feet (exposed).

Digitized by Google

(11.) Interval, 10 feet, probably red shale.

(10.) Sandstone, laminated, greenish-gray, micaceous, 3 feet (exposed).

(9.) Shale and fine, micaceous, argillaceous sandstone, 20 feet.

(8.) Sandstone, ferruginous, massive, close-grained.

(7.) Sandstone, coarse-grained, massive and distinct quartz grains in contact, apparently cemented by an oxide of iron resembling the Clinton Block ore near Beavertown, Union County. Thickness 3 feet.

(6.) Sandstone, rather massive, greenish, interstratified with green and red shales, 20 feet.

(5.) Sandstone, dirty green, pretty compact, becoming micaceous downwards, brown and very ferruginous, 13 feet.

(4.) Limestone, greenish, very silicious with pebbles and plates of green shale, hard and weathering with a worm-eaten aspect, 2 feet.

(3.) Sandstone, green, argillaceous, micaceous, laminated, 7 feet.

(2.) Interval, 45 feet.

(1.) Sandstone, light brown, micaceous, laminated: beneath the red shale at the river bank.

This section from the base of the Conglomerate No. XII down to the bottom of (2) shows a measured thickness of 196 feet, with two unmeasured intervals, (8) and (16.)

The whole aggregate thickness from the base of No. XII to the red shale at water level would probably be between 200 and 220 feet. The distance between the two sections at Wray's Hill and Riddlesburg is about 9 miles (air line). As the thickness of No. XI in that distance would probably not vary appreciably, the Riddlesburg section may be said to represent *a* of the upper member at Wray's Hill. The general character of the two is somewhat similar, the difference being no greater than might be expected when the circumstances under which the deposit was made are taken into consideration.

The coal seam, which is mentioned in (17) as occurring 100 feet above the limestone (14) is not, as reported above, in the "lower productive coals," but is an interconglomerate coal found between the upper and lower conglomerate members of No. XII, and probably identical with the coal bed No. 248 of our section.

b. This part is composed principally of gray and red sandstones, flags and shales, and is 520 ± feet thick. It is somewhat harder than the overlying mass and exhibits false bedding in the sandstones toward the top, as seen in Wray's Hill tunnel; the seams along the bedding containing calcite.

The strata here are not as argillaceous as those in the lower part of the member.

"*c.*" The lower subdivision is made up of very argillaceous shales and sandstones, easily weathered, forming a deep red-colored, clayey soil.

At Richmond Falls on the New River, W. Va., this series has a thickness of 1450 feet, distributed as follows: 3. Upper red and variegated

Digitized by Google

shales, 310 feet. 2. Middle gray and greenish sandstones, 820 feet. 1. Lower red shales and sandstones, 320 feet.

At Quinnimont on the Kanawha River, the transition layers between No. XI and No. XII are shown in the following section :

5. Black fissile slates and shales, 20 feet........................	210′
4. Thinly laminated, gray flags and calcareous shales containing in the upper part carbonaceous shales and strings of coal, 50 ft.	
3. Variegated marlites with some nodular limestones, 70 feet....	
2. Gray calcareous sandstone, 20 feet...........................	
1. Bright red shales, seen 50 feet..............................	

No coal was found in this series in Huntingdon County.

Prof. Wm. B. Rogers mentions a coal under the Conglomerate on little Sewell Mountain, which he queries equivalent to the Sharon Coal of Western Pennsylvania. He also notes the occurrence of a seam 4 feet thick in subdivision *b* west of Lewisburg, Greenbrier County, Va., and of two beds in Montgomery Co., one from 2 to 3½ feet thick, and the other from 6 to 9 feet thick composed principally of slate.

2. *The middle member* (Mountain Limestone) is made up of red and gray argillaceous limestone and red shale. The limestone and shale alternate so irregularly that it is hardly possible to distinguish any well-marked subdivisions. The whole thickness of this member is 49 feet, the correctness of which depends upon the identification of the variegated red and gray massive limestone No. 224 at New Grenada with that at the quarry worked by John Whitney, near Todd P. O.

The thickness of the series exposed at New Grenada is 35 ± feet. At the quarry worked by Whitney the highest limestone stratum exposed is No. 229, and the lowest No. 221, making 36 feet in all. But if the variegated red and gray limestone bed at New Grenada be the same as that near Todd P. O., then we neither found the lowest stratum at the former locality nor the highest at the latter; but the lowest exposure at New Grenada is 14 feet above the bottom of the series, while the highest near Todd P. O. is 13 feet below the top. The possible error (in the event of the erroneous identification of limestone No. 224) is 13 feet, which would make the thickness 36 feet instead of 49.

An analysis of the section shows the following divisions :

Upper	Red limestone No 231..................................	3′
	Red shale Nos. 229 and 230...........................	15′
	Red limestone No. 228.................................	2′6″
Middle	Red and gray calcareous shale Nos. 227 and 226......................................	5′
Lower	Red and gray limestone Nos. 225, 224 and 223..........	18′
	Red shale No. 222.....................................	6′
	Gray limestone No. 221................................	4′

Digitized by Google

On account of the great variability of the limestone beds, the above can hardly be proposed as a distinct division characteristic of the series.

To bring the section into accord with observations made at other localities, in the bituminous region of the State, it might be well for convenience of comparison to divide the series into an *upper* and a *lower* limestone member, separated by a middle mass of shale, as indicated.

Where the limestone was studied in Smith's and Plank Cabin Valleys, the *upper* member is composed of more impure and argillaceous beds than the *lower*, and the only parts of the series which have as yet proved of any very great economical value, are the variegated red and gray limestone No. 224, and the more massive gray stratum No. 223, the latter by analysis containing 92.32 per cent. of carbonate of lime.

In two localities *fossil* remains were found in the *upper* member. In Well's Valley to the south of Broad Top Mountain, near Wishard's old saw mill, a bivalve shell and a coral were found (Roger's Vol. I page 530), and at the quarry near Todd P. O., in Plank Cabin Valley, the following genera and species were collected from stratum No. 228, *Grammysia*, *Strophodonta*, *Rhynchonella* and *Terabratula Rœmingeri*. In No. 226 a *Centronella* was disclosed. A close study of the outcrop in Plank Cabin Valley would no doubt result in the finding of other species.

Prof. Rogers (Vol. I, page 472) reports that this limestone series can be traced from the Conemaugh River along Chestnut and Laurel Ridges to the Southern boundary of the State.

"It occurs as a more or less silicious limestone, containing well rounded grains of sand of a light blue color, sometimes having a yellowish tint. The upper part is remarkably full of fossils as is also the central mass of shale."

The series seems to feather to the north on the Alleghany Mountain near the sources of the Conemaugh, gradually augmenting through the southern part of the State and Maryland until in Greenbrier Mountain, Pocahontas County, W. Va., it attains a thickness of 822 feet, known as the Lewisburg limestone. It ranges in force still further south through Eastern Tennessee and Northern Alabama to the end of the Appalachian coal belt in the latter State. In the west the mountain limestone is known as the St. Louis and Chester groups.

Prof. Fontaine (Silliman's Journal, Jan. 1877) proposes the mountain limestone for a base to the Umbral (Mauch Chunk) No. XI; first, on account of the physical character and composition of the red shales between the Vespertine (X) and the limestone; second, on account of the subordinate position which the limestone would otherwise occupy in the comparatively restricted Umbral Series.

There are several objections to this classification:

1st. Although the red shale which occurs under the Mountain Limestone undergoes a rapid and progressive attenuation to the west and south-west, the limestone itself is not found in the anthracite region where the Mauch Chunk series has its greatest development, and is a red shale formation

Digitized by Google

"par excellence," having a thickness of 3000 feet at Mauch Chunk on the Lehigh river.

2d. There is no marked distinction in physical aspect or composition between the lower and upper members of No. XI either in Western Pennsylvania, where the limestone is found, or in Eastern Pennsylvania, where it is entirely wanting.

3d. The topography produced by the upper member of No. X is so different from that produced by the red shale XI below the limestone as to suggest a classical distinction between the two.

The lower member is made up principally of red sandstones and shales; with alternations of coarse-grained, gray and greenish-gray, flaggy sandstones and shales; the latter predominating toward the bottom.

The lower member is devoid of all remains of fossil life, as is also the upper member.

In the layers transitional between the Umbral (XI) and Vespertine (X) occurs an iron ore bed of some local importance in Trough Creek basin. Its precise stratigraphical position was not determined; but it is probably not far above what we have considered as being the top of No. X.

This ore of XI has been developed to some extent at the old workings of the Trough Creek furnace, at the eastern base of Terrace Mountain. "Here the bed occurred in balls closely imbedded in a little earth and was of a number of varieties." (Rogers, Vol. I, page 529.) "Several of these varieties were of a common compact brown ore, seldom exhibiting any hematitic structure, but having a smooth jaspery surface and brittle fracture."

"The Hopewell ore-openings display the ore bed on both sides of the gap cut through Terrace Mountain by Yellow creek. A tunnel 90 feet long reached the ore on the south side of the gap 90 feet below its outcrop, the ore being from 20 inches to 3 feet thick, interposed between the sandstone below and the red shale above, and interstratified with more or less clay. The adjoining red shale lies in thick but very soft strata, is friable and of an intense red color directly below the ore. Thin layers of a more sandy ore are interleaved with the red shale."

The three horizons of economical importance are therefore:

1, that of the Ore bed directly under conglomerate No. XII;

2, that of the Mountain limestone;

3, that of the Ore bed directly above No. X.

No. X.

Pocono (Vespertine) Sandstone.

Upper member (massive and flaggy sandstone), Nos. 212, 211 and 210		610 feet.	2133′
Middle member, 1. Coal bearing strata Nos. 209 to 158 inclusive, (New River series)	313	693 "	
2. Conglomeritic strata, characterized by false bedding, Nos. 157 to 127 inclusive	380		
Lower member (sandstone and shale), (Nos. 126 to 117)		830 "	

The series might be more properly divided into four members; but as the conglomerate beds and coal-bearing strata of the middle member are always found where coal beds have been discovered, the latter above the former, I have preferred to consider these two formations, which in themselves are so distinct, as constituting one member.

The upper member of the series is composed of coarse-grained, massive, brownish-gray and gray sandstone, alternating with thinly bedded and flaggy sandstones of the same color. Near the top there are a few beds of red shale and sandstone; and towards the bottom there are beds of black slate containing floral impressions.

The transition of the shales and sandstones of the lower member of No. XI into this upper member of No. X is rather sudden. The bottom of No. XI is rather argillaceous, while the top of No. X is very silicious; the sandstones in the former (XI) are fine-grained, thinly bedded and flaggy, while those in the latter (X) are coarse-grained, more massive, and recur with fewer alternations of shale than in the former case. The strata are thicker and the change from sandstone to shale less frequent. The upper member of X generally forms the flank of the ridge or mountain whose crest is formed by the lower part of the middle member. The eroded surface of the mountain being very nearly a plane surface, although sloping of course at a pretty high angle, it is seldom cut by streams running transversely to the strike, such as produce the gullies which are so characteristic of that flank of a mountain of Medina and Oneida (No. IV) formed by the Hudson shales; in fact the drainage is generally effected solely by the stream at the base of the mountain, following it in a parallel direction

The topography of the lower member of No. XI is very marked and quite different from that just described. It generally presents itself as a chain or succession of little hills or knolls, containing the outcrop of the limestone beds of XI, and separated by depressions through which the small streams descending from the flank of the mountain of XII, break just before they join the main stream of the valley flowing along the foot of the mountain of X. In the district lying east of the Broad Top Mountain the place to look for the limestone beds is alongside of and close to the principal stream, which therefore flows along the eroded outcrops of the soft red shales *below* the limestone. This suggests a third reason why the top of the Pocono or Vespertine sandstone should not be considered the base of the mountain limestone.

The middle member of X is subdivided into:

1. Coal-bearing strata, New River series.
2. Conglomerate and conglomeritic sandstone, characterized by false bedding.

The coal-bearing strata contain 19 seams of coal, with an average individual thickness of one inch and a half. Their thickness, if added together and combined with that of the numerous thinner seams and partings

Digitized by Google

scattered through the strata, and not precisely located in the section, would be sufficient to form a solid seam of coal about four feet thick.

The following analysis of the section shows the position of each coal bed and the feet of interval between, formed generally of sandstone :

29 feet	5 inches.		Sandstone, Nos. 209 and 208,—at the top.
		2½″	Coal (seam No. 19), No. 207.
76 "	3 "		Sandstone, Nos. 206 to 202 inclusive.
		2″	Coal (seam No. 18), No. 201.
1 "	6½ "		Sandstone, Nos. 200 and 199.
		3″	Coal (Seam No. 17), No. 198.
41 "	4 "		Sandstone, Nos. 197, 196 and 195.
		1″	Coal (seam No. 16), No, 194.
2 "	6 "		Sandstone, No. 193.
		1″	Coal (seam No. 15), No. 192.
	6 "		Sandy fireclay, No. 191.
		1″	Coal (seam No. 14), No. 190.
47 "	1 "		Sandstone, Nos. 189 to 186 inclusive.
		1″	Coal (seam No. 13), No. 185.
6 "	0		Sandstone, No. 184.
		3″	Coal (seam No. 12), No. 183.
6 "	0		Sandstone, No. 182.
		1″	Coal (seam No. 11), No. 181.
4 "	0		Sandstone, No 180.
		3″	Coal (seam No. 10), No. 179.
2 "	0		Sandstone, No. 178.
		1″	Coal (seam No. 9), No. 177.
1 "	0		Sandstone, No. 176.
		1 ′	Coal (seam No. 8), No. 175.
36 "	8 "		Sandstone, No. 174 and shale No. 173 directly above coal.
		1″	Coal (seam No. 7), No. 172.
	1 "		Fireclay, No. 171.
5 "	0		Sandstone, No. 170.
		1″	Coal (seam No. 6), No. 169.
	10 "		Sandstone, No. 168.
		2″	Coal (seam No. 5), 167.
	5 "		Sandstone, No. 166.
		2″	Coal (seam No. 4), No. 165.
17 "	0		Sandstone, Nos. 164 and 163.
		2″	Coal (seam No. 3), No. 162.
28 "	0		Sandstone, No. 161.
		1″	Coal (seam No. 2) No. 160.
5 "	0		Sandstone, 159.
		1″	Coal (seam No. 1), No. 158, at the bottom.

Fireclay occurs only under seams No. 7 and 15 ; that under No. 15, being very sandy.

Digitized by Google

The sandstone between the several seams has a great sameness of characacter, and is very much broken up by false bedding and fractures; in many cases it contains thin seams or partings of coal. The numbered seams and partings generally lie parallel with the true bedding of the strata, although in many instances *they are found along the planes of false bedding*. The thicknesses are very variable, in places increasing from 1 and 2 inches up to 10 inches and 1 foot; and sometimes a seam will be very much broken up and separated by a mass of sandstone, which splits the bed for some distance, but afterwards disappears, permitting the severed portions to unite again.

The almost total absence of fireclays under the coal seams, and the occurrence of coarse sandstone in many places directly above them seems to show that the coal has been derived from plants which may have grown at some distance from the locality and been afterwards floated and caught in the falling sediment, forming "drift beds." The period was undoubtedly one of continuous local current agitation as indicated by the coarseness and false bedding of the strata.

The lower part of the middle member is characterized more particularly by its beds of conglomerate and conglomeritic sandstone, both of which exhibit false bedding in a marked degree.

At the top of it directly under coal seam No. 1, comes No. 157 of the section, 25 feet thick, composed of soft black shale containing plates of coal and impressions of minute plants, alternating with a fine-grained conglomerate which contains micaceous specks. The surfaces of the shale are very much stained with iron. Directly below these alternating beds occur (No. 156) 26 feet of a yellowish-gray argillaceous shale also containing plates of coal and showing "slickensides," giving evidence of some contortion and slipping of the strata.

The first well defined and massive sandstone (No. 155 of the series) occurs below the shale; is 9 feet thick and is separated by 2 inches of black carbonaceous slate (No. 154) from 113 feet (Nos. 153, 152 and 151) of hard massive and conglomeritic sandstone, *showing a greater amount of false bedding than any other part of the section.* No. 152 contains a few alternating beds of black slate, but is *en masse* the hardest and most massive part of the Pocono or No. X epoch. It forms the crest of Sideling Hill, apparently throughout its whole extent; its position in the mountain can be seen both in Sideling Hill creek section and E. B. T. R. R. section accompanying the report of the Aughwick Valley. Below these harder and more massive strata there are 82′ 7″ (Nos. 150 to 144 inclusive) of shale, with a few beds of sandstone, the whole underlaid again by 25 feet of hard, massive sandstone (No. 143), and 13 feet (No. 142) of fine-grained conglomerate containing thin beds of black micaceous sandstone.

The general character of the section below this part is as follows:

Shale and sandstone (No. 141)	26 feet.	
Massive sandstone showing false bedding (No. 140)	17 "	0

Digitized by Google

Shale and sandstone (Nos. 139 to 133 inclusive)	5 feet 9
Sandstone (Nos. 135, 134, 133)	17 " 10
Shale (Nos. 133 to 128 inclusive)	4 " 6
Sandstone and shale (No. 127)	15 " 0

The sandstone and conglomerate, throughout the whole series, seem to alternate with the beds of shale as shown in the following grouping :

Shale	51′	380′
Sandstone	122′	
Shale	83′	
Sandstone	88′	
Shale	26′	
Sandstone	40′	
Shale	5′	
Sandstone	15′	

Throughout the upper member of this Pocono or Vespertine Formation No. X, and the coal-bearing strata of the middle member, remains of a terrestrial vegetation are more or less abundant both in the sandstone, shale and slate. The following genera and species have been determined by Prof. Leo Lesquereux in specimens collected from the débris at the west end of Sideling Hill Tunnel :

1. *Sphenopteris flaccida* (Crépin), a new species for America but recently discovered in Belgium, stage of the *Psammites du Condroz*, which correspond to the upper part of the Catskill (IX) of Pennsylvania; for the same formation has still a *Psilophyton* and *Palaeopteris hybernica.*

2. A species of *Ulodendron* with scar leaves obsolete. It seems to be quite near to if not identical with *Ulodendron majus* (Sternb.), a species found in the sub-conglomerate coal of Alabama, but ascends to and above the Conglomerate.

3. *Knorria acicularis* Göpp, from the transition measures of Silesia. It is new for this country but passes by decortication to the following:

4. *Stigmaria minuta* Lesq. First Geological Report of Pennsylvania, Plate XVI, fig. 1 and 2, from the Pocono (Vespertine) of Mauch Chunk.

5. A branch referable to *Stigmatocanna Wolkmanniana* Göpp, but not positively ascertainable, the bark of the tubercles being destroyed.

6. A *Lepidodendron* (?) in four twisted and compressed fragments, so much deformed that the outlines of the scars are not discernible.

Nos. 1 and 4 are the more predominant species and are represented by many fragments.

"The specimens were very hard to study and determine, as they are twisted in many directions and the vegetable fragments covered with a coating of coal as hard as graphite."

3. The *lower member* in its general character bears some resemblance to the upper member in as far as it is made up of alternations of sandstones and shales.

Digitized by Google

The sandstones are more argillaceous and not as massive; they are coarse grained and stained with iron, and at times contain red and yellow specks.

The shales are both argillaceous and silicious, and the alternations with the sandstone are more frequent than in the upper member.

The predominating colors of the sandstone and shale are gray, yellow, olive and green.

This member seems to contain more ferruginous matter disseminated through the strata than either of the other members, and quite frequently iron concretions are found.

The horizon between the Pocono (X) and Catskill (IX) is not very distinctly marked. The greatest distinction between the two is that of color. The upper strata of the Catskill are more argillaceous than those at the bottom of the Pocono, which fact in a measure determines the topography of the two.

Prof. W. M. Fontaine, in Silliman's Journal for January and February, 1877, gives a description and section of the Vespertine (Pocono, X) in West Virginia.

In Lewis Tunnel through the Alleghany Mountain, on the Chesapeake and Ohio R. R., he has constructed the following section:

135 feet. Upper part (30 feet) dark shales, olive and reddish marlites, below which occurs 10 feet of firm thin bedded black shale holding a local coal 12 inches thick. The lower half is composed of firm, silicious, rather coarse bluish-gray sandstone holding bits of lower rocks, drifted stems and coal beds.

Below this mass come the coal-bearing strata 215 feet thick, distributed as follows:

15′		Black sandy slates.
3′		Sandstone.
	6″	Coal, slaty.
5′		Fireclay containing rootlets.
	2″	Coal.
	1′	Fireclay.
30′		Gray sandstone with films and streaks of coal (floated).
1′		Black slate and coal.
8′		Brown flaggy sandstone.
	8″	Coal.
	5″	Fireclay.
5′		Bluish-black sandy shales.
50′		Gray flags.
—		Interval (?) feet thick.
20′		Olive sandstone.
40′		Argillaceous thickly bedded sandstone with thin films of coal and black shale.

Below this series occurs a white, pebbly, silicious sandstone, very persistent, at least 60 feet thick, the mass directly underneath being concealed.

Digitized by Google

From the base of this sandstone to the top of the red marls and sandstone (No. IX) there is a thickness of 500 feet, more or less, made up of flaggy sandstone with interstratifications of shales, all of which when fresh have a dingy yellow or brownish-gray color, but weathering to a dull brown.

Professor Fontaine seems to prefer calling the 60 feet at the base of the coal-bearing strata the base of No. X, but further states that the underlying 500 feet might perhaps be thrown into the Vespertine or Pocono Epoch. Judging from Fontaine's descriptions, to bring the section in harmony with the East Broad Top, I think it would be necessary to consider the lower 500 feet as included, making a total thickness for No. X of 910 feet, more or less, which would then be represented by 2133 feet at Broad Top, reversing the relationship in the two localities between No. XI and No. XII, both of which are thicker in the Virginia section than at Broad Top.

The general sections of Prof. Fontaine's, given in the text, I have compiled from his elaborately detailed descriptions in Silliman's Journals, to which the reader is referred.

No. IX.

Catskill (Ponent or Old Red) Sandstone.

Thickness (Nos. 116 to 108 inclusive), 2680 feet.

Character: consists for the most part of thick alternating red argillaceous shale and sandstone, and occasional beds of gray, yellow, white and green sandstone and shale. On account of its uniform composition it does not admit of sub-division either by its fossils or mineral composition. Unlike the groups of Nos. X, XI and XII, which gradually assume new phases, this series, undergoes no important modification other than that of thickness throughout the State.

The *upper* part of No. IX is composed of red shale and sandstone alternating with gray and whitish sandstone, containing micaceous specks. The *central* part seems to be made up principally of red flaggy sandstone and shale alternating with thin massive yellow, gray and white shaly sandstone; toward the bottom the red shale becomes more sandy, contains less alternations of gray shale and a number of imperfect remains of what apparently was a terrestial vegetation, the accumulation in some localities being sufficient to form small "drift beds" of coal. The *lower* part seems to contain a predominant amount of ferruginous matter, and the surfaces of the strata are sometimes slightly stained with a bituminous coating. No fossils were found in this mass other than a few remains of fish bones and scales, having a white and bluish tint in contrast with the red and brownish-red shale. The strata throughout the whole formation are very argillaceous, weathering very easily, which fact is beautifully illustrated in the deep cuttings made recently in Smith's Valley, on the line of the E. B. T. R. R.

Prof. Hall gives the following description of it as studied by him in Eastern New York:

"The Old Red Sandstone, where fully developed, consists of various

Digitized by Google

strata of sandstone, shale and shaly sandstone, conglomerates and impure limestones. The pervading color of the sandy parts is brick red, though often lighter, and sometimes of a deeper color, from a larger proportion of iron; while the coarser parts are often gray and the shales are green. Beds of green shaly sandstone are interstratified with the red friable sandstone, and these are succeeded by a compact kind of conglomerate rock."

The following section of the Red Catskill is given by Prof. Fontaine (Silliman's Journal, January, 1877), constructed near Lewis Tunnel on the Chesapeake and Ohio R. R., W. Va.:

No. 3,	150′ ±	Red marl and sandstone, containing more sandstone than No. 2.	340′
No. 2,	70′	Dark red marlites with ochreous and very argillaceous sandstones. Balls and nests of limonite and decomposed pyrites.	
No. 1,	120′	Deep red marlites alternating with thick bedded and argillaceous reddish-brown sandstones in about equal proportions. These are underlaid by coarse sandstones containing Chemung fossils.	

No. IX is between 1,000 and 2,000 feet thick where it outcrops south of the anthracite coal fields, and on the south flank of the Catskill Mountains in New York. In the northern counties of Pennsylvania and in the north flank of the Catskill Mountains (N. Y.) it is probably between 400 and 600 feet thick.

This Formation forms the mass of the Catskill Mountains of New York, and the middle flank of the Pocono Mountains on the Pennsylvania side of the Delaware River. After passing the Lehigh River, its strata assume a vertical attitude, and the outcrop of its harder parts makes the southern of the two crests of the Second Mountain nearly to the Susquehanna River. Wherever the dip approaches 45° the red Catskill sandstones of IX form a bold terrace on the flank of the mountain, the crest being made by the Pocono sandstone of X, as in Peter's Mountain, at the mouth of the Juniata. Along the face of the Alleghany Mountain, this terrace of IX is cut up into a series of buttresses projecting from the escarpment. Around Broad Top the same *terrace structure* has given occasion for the name Terrace Mountain, which is merely the prolongation (in a curve backward) of the Sideling Hill which our Section crosses.

The formation contains in the Broad Top country no stratum of any economical importance. An iron ore bed occurs about 400 feet below the upper horizon. Its thickness is undetermined, and it was merely located from its outcropping on the north-west side of Smith's Valley, where it occurred as a very silicious brown hematite. It will probably never prove to be a workable bed.

Transition strata between the Catskill and Chemung epochs:

Thickness (Nos. 107 to 96 inclusive) 90 feet.

Character: Consists of yellow, red, green and olive shale and sandstone.

Digitized by Google

The surfaces of some of the sands'one strata contain a fine exhibition of ripple marks and impressions of fucoids and characteristic Chemung fossils, *Spirifer disjuncta*, *Rhynchonella*, &c.

Thirteen feet from the bottom occurs a brown ferruginous sandstone, No. 101, weathering readily on the surfaces from the oxidation of the iron, the representative of the Larry's Creek ore, which has a continuous range through parts of Lycoming, Clinton and Tioga counties. It attains its maximum thickness on Larry's Creek in Lycoming County, where the principal bed is 3 feet thick. In some localities it resembles closely the Cleveland ore of Yorkshire, England. In this portion of the State the bed is not workable.

No. VIII.

Chemung (Vergent) shales.

Thickness (Nos. 95 to 85 inclusive), 1860 feet............ }

Portage (Vergent) flags. } = 3310′

Thickness (Nos. 84 to 71 inclusive), 1450 feet............ }

The limits of the Chemung and Portage taken together are well defined, the upper being topped by the transition strata at the base of the red Catskill, and the lower by the olive slaty and shaly sandstone of the Hamilton period. The horizon between the two epochs is not as well defined and it has been located rather arbitrarily. There are certain large distinctions between the two which it may be well to notice before describing each in detail.

Both are made up of alternations of shales and sandstones. In the Chemung the strata are more silicious, while in the Portage they are more argillaceous. In the latter the sandstone is always finer grained and the shale more clayey than in the former. The Portage sandstones are flaggy and at times very shaly, and their alternations with the shale are very frequent, although the individual strata are quite thin, the shale predominating. The sandstones of the Chemung are more massive, occur in thicker strata, their alternations with the shale are less frequent and they seem to contain more ferruginous matter, and more micaceous specks. The Chemung strata, particularly the shaly sandstones toward the top, are replete with marine mollusca, particularly brachiopods, while the Portage is extremely poor in fossil life, with the exception of crinoid stems and sea weeds, or fucoids; although the occurrence of fossil fucoids would not distinguish the epoch, since they are also very abundant in the upper part of the Chemung, but possibly the two are of different types.

The *upper part of the Chemung* is composed of olive-brown and gray massive and sometimes argillaceous sandstone alternating with flaggy sandstone, and red and green shale, both shale and sandstone containing ferruginous specks.

The *central portion* of the epoch is made up principally of brown, red and gray sandstone and shale: the sandstone is probably more massive than

Digitized by Google

it is in the upper part, and besides ferruginous matter contains micaceous specks.

In the *lower part* the general character of the strata is very much the same, although apparently containing less iron and mica than the central part.

In descending from the top to the bottom of the epoch the sandstone which in the upper part seems to predominate, diminishes, while the shale increases, and the alternations of the two are greater, although of course the sandstone strata must be thinner. The upper part contains the greatest number of remains of fossil life.

The *general character of the Portage* seems the same throughout. The upper part is composed of rather massive brown and gray sandstone alternating with beds of olive and gray shale from 10 to 30 feet thick. Toward the centre the sandstone becomes more flaggy and occurs in thinner strata, while the shale becomes more argillaceous, forms thicker beds and is more varied in color. As we approach the lower horizon the sandstones become thinly laminated and occur in beds but a few inches thick; the shale is extremely argillaceous and weathers readily into clay. The shale, throughout the whole epoch, contains more or less iron, which on exposure readily washes out and is oxydized on the surface, coloring the shale in various shades of yellow, brown and red.

In New York, Prof. Hall reports (1843) that "the upper part of the Chemung is characterized by a general tendency to conglomerate, or gravel. In a few localities the mass becomes a well characterized pudding-stone. This conglomerate (continues Mr. Hall) nowhere attaining sufficient thickness or importance to merit a distinct description."

It is worthy of notice that this conglomerate, which forms several notable "rock cities" in South-western New York and which, probably, is the northern extension of one of the sands of the oil group of Western Pennsylvania, seems to be without even a representative at Broad Top. Although the sandstones toward the top of the Chemung are massive and coarse grained, yet there seems to be no tendency to conglomerate or gravel.

Again, cross lamination, or oblique, or current bedding, ripple marks, concretions and limestone strata which are so abundant in the Chemung and Portage Epochs in New York, are wanting in Central Pennsylvania. The ripple marks in a measure are an exception to this assertion, although they are comparatively rare, and though sometimes met with, they would not be difficult to overlook, especially after studying the fine exposures in the transition layers between No. VIII and No. IX along the E. B. T. R. R., those in the lower Catskill in Smith's Valley, and again in the bottom of the Hamilton on the Aughwick near Potts's Gap.

The absence of the limestone or limy shale and concretions may be attributed to the limited remains of marine life. These in New York are found in great colonies. Not only do we not find any limestone or limy shale, but the whole period is particularly devoid of any calcareous matter

Digitized by Google

in the cementing material of the sediment. This is readily shown by the rapid weathering of not only the shale but also the harder sandstone strata in the cuts along the E. B. T. R. R.

Professor Rogers (Final Report Vol. I, page 141) says of the Chemung: "This formation, remarkable for its general uniformity of composition, appears to have its maximum development in the region of the Juniata near Huntingdon, half way across the Appalachian chain, where its thickness is 3200 feet." Without reference to its thickness and character in other localities our measurement of its thickness (1950 feet) near Huntingdon seems to show that the above generalization is hardly well founded.

The Chemung formation makes both ridges and valleys. The upper part forms a ridge parallel to the mountain of X. The valleys are generally narrow and sharp, for the most part running parallel with the strike.

Portage rocks make also ridges and valleys, the ridges not as prominent as in the Chemung, and the valleys and ravines more irregular, not having such a great tendency to be parallel with the strike of the rocks.

The mass contains no strata of economical importance. Some of the sandstones are quarried to a limited extent for building stone. The sandstones and conglomerates forming the "oil sands" of north-western Pennsylvania, which are perhaps cotemporaneous with the Chemung Epoch, have no representative at Broad Top.

Genesee (Cadent Upper) Slate.

Thickness: (Nos. 70 to 67 inclusive) 325 feet.

Character: Consists of olive, slaty and shaly sandstone alternating with brownish-gray flaggy sandstone and dark olive shale; toward the lower part the sandstone strata disappear, and the shale becomes more argillaceous, until finally at the bottom we have dark olive fissile slate with occasional seams of a bright brown-colored sandstone from 2 to 4 inches thick. The shale and slate are slightly bituminous and stained with iron.

These rocks form valleys and are of no economical importance.

Hamilton (Cadent) Shale.

Thickness: (Nos. 66 to 63 inclusive) 635 feet.

Character: Consists in the *upper part* of gray sandstone flags and shales; toward the central part the sandstones predominate in a three-fold character of massive, flaggy and slaty, to the exclusion of the shale. Surfaces of the sandstones are stained with iron and contain the following fossils: *Aviculopecten princeps, Chonetes mucronatus* and *Chonetes coronata, Grammysia, Spirifer granulifera, Spirifer mucronatus, Tentaculites,* and *Algæ,* more particularly *Spirophyton caudagalli.*

In the *lower part* the sandstone is not so massive, being more flaggy and shaly; the flaggy sandstone at times becoming quite calcareous, and is very much stained with iron. Shale alternates with sandstone, and toward the bottom predominates, being of a gray and dark olive color, sometimes thinly laminated and fissile.

Digitized by Google

Along the Aughwick creek near Potts's Gap in the lower strata there is a fine exhibition of ripple marks.

These rocks make ridges and in the Aughwick Valley are not of economical importance; in New York the Hamilton contains a number of very fine flagstone quarries.

Marcellus (Cadent Lower) black slate.

Upper member	(Nos. 62, 61 and 60)	571 feet.	} 875′
Middle "	(No. 59)	20 "	
Lower "	(Nos. 58, 57 and 56)	284 "	

This formation might be more properly divided into an upper and lower portion as the lithological characters of each are quite distinct; what we have called the middle member may prove to be but locally deposited.

The *upper member* consists of brown, gray, olive and black argillaceous shale with occasional seams of flaggy and slightly calcareous sandstone in the upper part, and seams of non-calcareous sandstone in the lower part. The sandstone and shale, but more particularly the latter, are very much stained with iron and bituminous matter.

The *middle member* is made up of shaly argillaceous limestones, alternating with greenish-gray lime shale. The exact position of this member of the series may be a little above or below that given in the section. The only place where it seemed possible to study this portion was in the valley of Blacklog Creek, near Orbisonia, where the dip of the strata was rather uncertain, and too far from the section line to make its position certain. Although it has been thought best to suggest only a local deposit of this limestone, economically considered, yet it seems quite certain that the horizon may not be more calcareous in one locali y than in another, but, on account of the associated strata being very argillaceous, the carbonate of lime may be more generally disseminated in one place than in another: in the former case producing nothing but a calcareo-argillaceous shale, and in the latter case an argillaceous limestone.

The *lower member* consists of black fissile slate and black and brown shale, the surfaces of both being very much stained with iron and coated with bituminous matter. In this lower member in the valley of the Juniata, above and below Lewistown, occur irregular deposits or beds of coal, the vestiges of a vegetation which appears to have been air breathing or terrestrial. The lower horizon of the series is marked by an important ore bed No. 56 which primarily is a proto-carbonate of iron but which has been changed at its outcrop by atmospheric action into a brown peroxide of iron.

It is not an infrequent thing to find the black shale and slate of the lower member very much contorted and dipping in an opposite direction to the general lay of the strata. These transverse dips are seldom of any extent and if relied upon lead to errors in constructing a section. It seems probable that some of the faults which have been located in the Marcellus and

Digitized by Google

associate strata may have been based upon observed dips in the lower member.

The epoch is valley making and has three horizons of more or less economical importance.

The *Marcellus iron ore* bed is of great importance from the Juniata River to the Maryland State line and supports a large iron industry. It varies in thickness from 3 and 4 up to 10 feet, occurring as a series of solid gray layers separated by thin seams of slate. In its native proto-carbonate condition it is a bluish-gray or lead colored ore, sometimes massive, breaking into square pieces, and at other times of a slaty or laminated structure. Where the ore has not been thoroughly subjected to atmospheric action the change to brown peroxide is only partial, a solid nucleus forming the interior of the lump, while the peroxide occurs on the surface as a crust of greater or less thickness.

The following are two partial analyses made by Mr. A. S. McCreath, Chemist of the survey, of ores from the end of Jack's Mountain:

	Fleck's bank.	McCarthy's bank.
Iron	46.5	39.100
Manganese	——	.201
Sulphur	trace	.430
Phosphorus	.133	.060
Insoluble residue	17.120	——

Upper Helderburg or Corniferous Limestone (*Post Meridian*).

Thickness: Three Springs and Saltillo (Nos. 55 to 47 inclusive), 60 feet.

Character: Consists of dark blue and gray argillaceous limestone alternating with green, olive and gray calcareous shale. Prof. Rogers, in the first report, says: "That the post meridian series may scarcely be called a Pennsylvania deposit as it only enters the eastern borders of the State near the Delaware Water Gap." He includes the calcareous beds which have been placed in the section as Upper Helderberg in the Marcellus Epoch; but as the limestone strata seem to be very generally distributed through the centre of the State and as they must owe their origin to dynamical conditions entirely different from those existing during the black slate deposition above, from which they differ so widely lithologically it seems more reasonable to consider the limestone as representative of the New York Upper Helderberg until the division can be established palæontologically, or on other than purely lithological grounds.

These rocks form one flank of the ridge made by the Oriskany. Some of the more massive limestone strata are quarried, the stone on being burned making a poor lean lime. In some places the formation contains a rather poor argillaceous carbonate of iron (ore bed). The Hawk Mine, worked by the Rockhill Iron and Coal Co. north of Orbisonia, is located on this bed, which appears to be a local deposit.

The petroleum of Canada, according to Prof. T. S. Hunt, is indigenous to this formation.

Digitized by Google

No. VII. *Oriskany (Meridian) Sandstone.*

At Three Springs, Nos. 45, 44 and 43.......Thickness.......	58	feet.
At Orbisonia................................ "	150 ±	"

The *upper part* is composed of a coarse-grained ferruginous and calcareous sandstone containing a great deal of iron toward the top, and is surmounted by a bed of ochreous clay.

The *central portion* is made up of a loose, friable sandstone containing pebbles the size of a pea, larger than any found in the upper or lower parts.

The *lower part* consists of a coarse-grained, arenaceous sandstone more fragile than any toward the top of the mass, and breaking into more irregular shapes. The sandstone contains a great deal of ferruginous matter and the surfaces are at times coated with peroxide of iron.

The epoch contains the following fossils: *Cyrtoceras expansus, Dalmania micrurus, Eatonia peculiaris, Megambonia lamellosa, Orthis hipparionyx, Platyceras ventricosa, Pterinea texilis, Rensselaria marylandica, Rensselaria ovalis, Rensselaria ovoides, Spirifer arenosus* and *Spirifer arrectus.*

The species of marine life found in the lower Helderberg limestone seems to have been cut off by the changes which ushered in the Oriskany Epoch, a group of fossils peculiar to it assuming their place. Most of the fossils are remains of mollusks, no vertebrates or remains of land plants have yet been found. So far Palæontology seems to assign a distinct place to the Oriskany between the Silurian and Devonian ages. Viewing the dynamical conditions attending the deposition of the Devonian age Dr. Newberry places the Oriskany at its base; and says: "The Devonian rocks of Ohio form a circle of deposits, which records an invasion of the land by the sea, and presents in its series of strata, a history of the successive stages of that invasion; first, the mechanical sediment of the Oriskany; then the Corniferous limestone, the deposit of the open sea; then mixed mechanical and organic materials; the mechanical sediments finally pre dominating and indicating a return to land conditions over all the eastern portion of the continent."

The epoch is ridge making, and has three horizons of economical importance:

1st. Upper ore bed, occurring at the upper limit of the sandstone. This bed is seldom workable in Pennsylvania, but is very productive in the valley of the James river, Virginia. In many localities the mass consists merely of the upper strata of the sandstone strongly impregnated with peroxide of iron.

2d. In the Juniata Valley where the Oriskany is friable and contains little or no iron, it affords a valuable sand for glass manufacture.

3d. Lower ore bed, occurring at the junction of the coarser and more arenaceous strata at the bottom of the sandstone with the soft, calcareous yellow layers beneath it. This bed is worked by the Rockhill Iron and Coal Company near Orbisonia and in Hill Valley.

Digitized by Google

No. VI. *Lewistown (Pre-meridian—Lower Helderberg,) Limestone.*

Thickness: (Nos. 42 to 38 inclusive) 162 feet.

Character: Consists of massive, dark blue and gray, semi-crystalline limestone, containing toward the upper and lower parts alternating layers of gray shaly limestone and argillaceous lime shale. To the north-east in the Juniata Valley from Mount Union to Lewistown, the shale at the top of the mass becomes a thicker and more distinctive formation. There are fine exposures of the series along the Kisicoquillas creek, near Lewistown, Mifflin County, where it was found necessary to give it a new geographical name in the failure to identify it with any of the sub-divisions of the lower Helderberg group in New York.

The following fossils have been determined: *Acervularia, Alveolites minima, Astylospongia inornata, Merista lævis, Orthis oblata, Pentamerus galeatus, Rhynchonella formosa, Astylospongia, Atrypa reticularis, Aulopora, Conophyllum, Merista arcuata, Stromatopora, Trematospira formosa,* and *Zaphrentis.*

This formation with the Oriskany is ridge making, and of great economical importance, as it furnishes good lime for building and agricultural purposes, besides being an excellent flux in the iron furnace. A specimen from Saltillo contained: Carbonate of lime 90.904; carbonate of magnesia 2.162.

An iron ore having a laminated structure occurs sometimes scattered in the soil overlying the limestone.

Water-lime (Scalent) Cement Beds.

Thickness: (Nos. 37 to 28 inclusive) 580 feet.

Character: Consists for the most part of a blue and gray flaggy and thinly bedded limestone having a wavy stratification. Toward the top the limestone is massive, slightly argillaceous and of a dark gray and bluish-gray color; but toward the bottom it becomes flaggy, thinly laminated and shaly, having a brownish-gray and yellow color. In the lower part limestone alternates with green, yellow and gray argillaceous shale.

The strata in the central part contain a great deal of calcite, and the surfaces of the stone are oftentimes coated with carbonaceous matter, and show "slickensides." The limestone beds are frequently highly magnesian, and a few may be compared economically with the Lewistown limestone. The outcrops occupy a small valley at the foot of the Oriskany ridge

Onondaga (Scalent) Marls.

		Saltillo and Three Springs.	Orbisonia.
Thickness:	Upper member Nos. 27, 26 and 25.....	170 ± feet.	145 feet.
"	Lower " " 24, 23 " 22.....	270 ± "	230 "

The upper member consists of yellow, gray and greenish shaly and argillaceous (fossiliferous) limestone in thin beds, alternating with olive, green and gray calcareous shale.

The lower member consists of green, yellow and gray calcareous shale,

Digitized by Google

alternating with red shale and containing occasional beds of fossiliferous, shaly limestone.

The Salina group thins in this district to the south-east, being thicker on the Jacks Mountain range than it is along Blacklog Mountain. It makes a valley and is of no economical value.

Niagara Limestone.

The Niagara limestone seems to be without a representative in Pennsylvania.

In a section which was constructed through Jacks Mountain at Mount Union, a limestone bed 3 feet thick was located 232 feet above the top of the Clinton red shale, which was supposed to be the representative of the Niagara limestone; the intervening space between this and the Clinton being filled with a soft, argillaceous, calcareous shale. The occurrence of the Niagara limestone here, as well as at Logan Gap 25 miles to the north-east, where a similar bed 4 feet thick was found, is extremely doubtful. A careful search for its representative at Rockhill Gap in Blacklog Mountain, and on each side of the Jacks Mountain anticlinal at Three Springs, and Saltillo, failed to bring it to light. It is questionable in the author's mind whether the Niagara measures which form such a marked feature in the geology of northern New York has in this section of Pennsylvania a distinct representative. While this epoch seems to be vacant in our palæozoic column, the Salina rocks, which occur directly above the Niagara, seem to be totally different in character from the New York strata, where they are composed of shales, marls and marly sandstones with impure limestone; ours being almost entirely destitute of fossils. Is it not possible that the strata which are included between the bottom of the Water lime shale and the top of the Clinton red shale represent equally or conjointly the Salina and Niagara groups of New York?

No. V. *Clinton (Surgent) Shales.*

		Saltillo.	Orbisonia.
1. Red shale (Nos. 21, 20 and 19)..........	Thickness	270 feet.	233 feet.
2. Upper olive shale (Nos. 18 to 15 inclusive)	"	162 "	163 "
3. Ore sandstone and fossil ore (Nos. 14 to 11)	"	42 "	54 ± "
4. Lower olive shale (Nos. 10 and 9).......	"	— "	660 "

1. The upper part of the red shale consists of silicious massive red shale having a rhombohedral fracture. Toward the lower part the red shale becomes more argillaceous and contains thin alternations of gray and green calcareous shale, while at the bottom there are beds of red shaly sandstone having seams of calcite running through the mass.

2. The Upper olive shale consists of yellow, olive and gray calcareous shale containing seams of blue fossiliferous limestone; the lower part forming the hanging wall of the fossil ore beds is composed of a light yellow argillaceous lime shale.

3. The fossil iron ore beds occurring above the ore sandstone have been extensively developed in Rockhill Gap by the Rockhill Iron and Coal Co.

Digitized by Google

Beside seams Nos. 12 and 14 of the section there are two other small beds below the ore sandstone. The first, from 4 to 6 inches thick, occurs directly under the sandstone and about 50 feet below the upper beds (C. Constable). The second is 10 inches thick and about 4 feet below the first. These two beds have never been worked. The beds above the sandstone are worked on the south side of Rockhill Gap by two drifts 100 feet vertically apart and having an average course of S. 21° W. The same beds are worked also on the north side of the Gap by two drifts which are about 60 feet vertically apart, the strike being about the same as on the south side. The course of the south drifts when continued across the Gap to the north side strikes about 100 feet to the west of the north openings, the ore range being thrown to the east on the north side by a fault which runs through the Gap at right angles to the strike. In gangway No. 1 on the south side the yield of a specimen was as follows:

	No. 14.	No. 12.
Iron...........................	50.800 per cent.	50.700
Sulphur........................	trace.	trace.
Phosphorus.....................	.112	.123

The ore sandstone has a thickness of 42 feet at Saltillo and of 50 feet at Orbisonia.

The sandstone varies very much in character in the different localities, as to the amount of calcareous matter which it contains; at Rockhill Gap it is very silicious, while at Saltillo it is quite calcareous. In the latter locality the ore beds seem to be represented by a calcareous sandstone containing a large percentage of iron, but not a true iron ore.

The sandstone generally forms a terrace along the flank of the mountain of No. IV.

4. Lower olive shale (Nos. 9 and 10).—Thickness: 660 feet.—For description see section

The following fossils were found in the Clinton Epoch, more particularly in the upper olive shale: *Atrypa reticularis, Beyrichia lata, Buthotrephis gracilis, Dalmania limulurus, Homalonotus delphinocephalus, Orthis elegantula, Platyostoma niagarensis, Pterinea emacerata, Rhynchonella neglecta* and *Strophomena rhomboidalis.*

No. IV. *Medina (Levant) Sandstone,*

White sandstone, No. 8........................	Thickness 400 feet.	1330′
Red sandstone and shale, No. 7................	" 930 "	

The white sandstone contains in New York several characteristic fossils, some of which the marine plants, and more particularly the *Arthrophycus harlani,* are found throughout its whole range from Pennsylvania to the south border of Tennessee.

The red sandstone and shale member is in Pennsylvania entirely destitute of fossils, and is a coarser and more sandy rock, than in New York, where it is composed principally of a finely-comminuted red marl or a calcareous red clay, containing a few organic remains.

Digitized by Google

A deposit of iron ore exists in the white Medina forming the crest of Blacklog mountain 4 miles south-west of Orbisonia. The ore and clay in which it lies seem to fill a transverse fissure or cleft in the white sandstone, at a point where there is a slight indentation in the crest of the mountain.

Oneida (Levant) Sandstone.

Upper member, red and greenish-gray silicious breccia and conglomerate, No. 6, thickness 158 feet.	}	568′
Lower member, hard massive, greenish gray sandstone and conglomerate, No. 5, thickness 410 feet.		

A striking feature of the epoch is its poverty in organic remains.

The Medina and Oneida rocks taken together make "all the mountain ridges and higher spurs of the entire chain west of the Susquehanna, between the Kittaning valley and the valley at the base of the Alleghany mountain," except those surrounding the Broad Top synclinal basin.

No. III. *Hudson River (Matinal) shale.*

Thickness: (No. 4) 800 feet.

Utica (Matinal) slate.

Thickness: (No. 3) 1070 feet.

The upper limit of No. III is well defined by the rapid and sudden transition of the Oneida gray sandstone and conglomerate into the argillaceous sandstone at the top of the Hudson River slates. The lower limit has been assumed at a very lean, poor shaly brown hematite ore, which seems to occur at the horizon between the shale and slate of the Utica and the blue calcareous shale at the top of the Trenton or Matinal limestone mass. The division between the Hudson and Utica was not positively determined, and may possibly be above or below the position which has been given it. Unconformability has been asserted to exist between the Hudson and Oneida.

Prof. Rogers speaks of it as follows: "The relations of the Matinal series to the overlying Levant strata * * * plainly show that * * * the earth's crust experienced a prodigious movement at the close of the Hudson period. This agitation of the floor of the sea, which had just received the materials of the Hudson shales, appears to have been everywhere attended by an extensive displacement of its level, accompanied in some districts by undulations amounting even to a close plication or corrugation of its sediment, and in some districts to a lifting up of wide areas above the general sea level into dry land."

The slates of No. III make one flank of the mountain of No. IV, and contain no strata of economical value in this district.

No. II. *Trenton (Matinal) limestone.*

Thickness: (No. 2) 500 ± feet.

The thickness of the epoch is only approximately determined from a

Digitized by Google

very limited observation in Blacklog valley. A very distinct palæontological break exists between this epoch and the underlying auroral magnesian limestone, the upper strata of which are exposed in the centre of Blacklog Valley opposite Rockhill Gap. It is probable that the Magnesian rocks in this part of Pennsylvania are at least 3000 feet thick, which would place the top of the Potsdam sandstone (the lowest group in the Palæozoic column), at least three quarters of a mile vertically beneath the present surface of the centre of Blacklog Valley.

Localities where the Strata were Measured and Studied.

No. XIII.

Nos. 267, 266, 260, 256 and 252. Robertsdale, Trough Creek coal basin, Carbon Township.

Nos. 265 to 261 inclusive. Coal bed D (Lower Freeport ?) Section measured about 400′ from mouth of mine C¹, Robertsdale collieries.

Since the section was compiled, I have been informed by Mr. Wm. A. Ingham, President Rockhill Iron and Coal Co., that a bed of black band ore has been discovered in the "Swamps" in mine C′, between the bottom bench of coal and the fireclay floor, ranging from 1 to 4 inches thick and yielding 30.79 per cent. of metallic iron.

Nos. 259, 258 and 257. Coal bed C (Kittanning ?) Section measured about 200′ from mouth of mine B¹, Robertsdale collieries.

Nos. 255, 254 and 253. Coal bed B (Clarion ?) Section measured by Wm. Foster, Esq. in mine A, Robertsdale collieries.

No. 251. Coal bed A (Brookville ?) Section reported by Wm. Foster, Esq. "Monkey drift," Robertsdale collieries.

No. XII.

No. 250 to 244 inclusive. Rocky Ridge near Wray's Hill Tunnel, Todd Township and Wray's Hill, Carbon Township.

No. XI.

Nos. 243, 242, 241 and 240. Wray's Hill and Rocky Ridge.

No. 239 to 234 inclusive. Wray's Hill Tunnel E. B. T. R. R.

Nos. 233 and 232. Ground Hog and Plank Cabin Valleys, Carbon Township.

Nos. 231 and 230. New Grenada, Taylor Township, Fulton County.

No. 229 to 220 inclusive. Limestone quarry worked by John Whitney, Esq., near Todd P. O., Plank Cabin Valley.

No. 219. Ground Hog and Plank Cabin Valleys.

No. 218 to 213 inclusive. Well on Ezra Heater's farm, one mile south of Todd P. O., section reported by Mr. Chas. E. Billin.

No. X.

No. 212. Ground Hog and Plank Cabin Valleys.

No 211 to 124 inclusive. Sideling Hill Tunnel E. B. T. R. R.

No. 123 to 117 inclusive. Smith's Valley. Clay, Cass and Union Townships.

The total thickness of No. X was verified by measurements made in Sideling Hill Gap, Fulton County.

Digitized by Google

No. IX.

Nos. 116, 115, and 114, Smith's Valley.

No. 113, J. B. Moreland's farm, Smith's Valley near Sideling Hill Tunnel.

No. 112 to 108 inclusive. Smith's Valley, along line of E. B. T. R. R. and Sideling Hill Creek. Deposits of "drift coal" in No. 109 found on Wm. Smith's farm, 1½ miles from Mapleton, Union Township.

No. 107 to 96 inclusive. Transition strata. R. R. cut end of Clear Ridge, north-west of Saltillo, Clay Township.

No. VIII.

No. 95 to 85 inclusive. Line of E. B. T. R. R., north-west of Saltillo and Sideling Hill Creek, Clay Township, and Coaling Ridge, Cromwell Township.

No. 84 to 71 inclusive. Line of E. B. T. R. R., north-west of Saltillo, and north-east of Three Springs, Clay, Springfield and Cromwell Townships.

No. 70 to 67 inclusive. Sideling Hill Creek and line of E. B. T. R. R. north-west of Saltillo, Clay Township and north-east of Three Springs, Springfield and Cromwell Townships.

No. 66 to 63 inclusive. North-west of Saltillo, Clay Township and Saddleback Ridge, Springfield and Cromwell Townships.

Nos. 62, 61, 60, 58, 57, and 56. North-west of Saltillo, north-east of Three Springs and Aughwick Valley near Orbisonia.

No. 59. Quarry near I. Engeart's house, 1 mile from Orbisonia.

No. 55 to 47 inclusive. R. R. cut at Three Springs.

No. VII.

Nos. 45, 44 and 43, R. R. cut at Three Springs. Fossils were found on end of Royer and Sandy Ridges near Orbisonia.

No. VI.

No. 42 to 38 inclusive. Near Three Springs, Saltillo and Orbisonia; fossils found at latter locality.

Nos. 37, 36 and from 34 to 28 inclusive. Near Saltillo. Three Springs and Orbisonia.

No. 35, Rockhill Furnace water-lime quarry near Orbisonia.

No. 27 to 22 inclusive. Near Saltillo and Three Springs.

No. V.

Nos. 21, 20 and 19. Near Saltillo and Three Springs.

No. 18 to 15 inclusive. Near Saltillo and in Rockhill Gap, Cromwell Township. Fossils found at Rockhill Gap.

Nos. 14, 13 and 12. South fossil ore mine, Rockhill Gap.

No. 11, Rockill Gap and opposite Leas and McVitty's tannery at Saltillo.

No. 10 and 9, Rockhill Gap.

No. IV and III.

No. 8 to 3 inclusive. Rockhill Gap.

No. II.

No. 2 and 1, Blacklog Valley, Cromwell Township.

Digitized by Google

Coahuila.

By Thomas L. Kane.

(*Read before the American Philosophical Society, January* 19, 1877.)

I. GEOGRAPHICAL.

I have recently returned from a three months' excursion into Northern Mexico. I went by rail to near San Antonio, Texas; from there took my own and government servants' wagons and mule teams. I was in no hurry, carried a party of intelligent friends with me as observers, and enjoyed advantages for seeing the country and its people which do not commonly fall to the lot of travelers.

I spent most of my time in Coahuila and Nuevo Leon. After visiting the country north-west of Piedras Negras, I looked up the different passes of the Sierra Madre which appeared inviting for railroad purposes from below Santa Rosa to La Rinconada. Finding Saltillo closely invested by Treviño, I crossed from the Saltillo road to Monterey, and thence returned to San Antonio via Mier and Laredo. I expect to have time soon to prepare a geographical paper and maps for the Transactions of the Society. I shall ask their patience this evening for the communication of a few facts not undeserving their notice.

I have drawn upon the blackboard, upon an enlarged scale, the leading features of Colton's latest Map of Mexico. I would ask your attention first to the contrast presented by the Rio Bravo to the other rivers of Southern Texas and Mexico. These are all greatly less conspicuous. They are seen to flow but short distances from their sources to the Gulf of Mexico. The Bravo or Grandè del Norte, on the other hand, cuts a more important figure on the map, outdoing, apparently, the others put together. It is of much greater length and volume, and the reason is obvious.

By the contour lines, where you observe my effort to make hatchings with the yellow chalk, I indicate in a general way the course of the high land which is customarily spoken of as the East Branch of the Sierra Madre. From San Luis Potosi, here, (A) I have drawn the so-called Sierra as extending to the edge of the plain watered by the Rio Grande (B). It sinks as it proceeds north, until here, you see, only one mass of mountain north of Santa Rosa, I have represented it as entirely disappearing.

We have here our explanation of the greatness of the only Mexican great river, the Rio Grande. The great river, you remark, rises in the interior, more than half way across the continent, and it flows all this way as many as 1800 miles, to the Gulf; because no mountain obstacle is offered to its progress. It finds what might be regarded as a vast Pass where the "Sierra" has gone under. It is true (this is a parenthesis for our Secretary) that here (a) it is deflected, and, obedient to local geological orders, turns nearly at right angles, and works along at disadvantage for some distance, until it hits this seeming continuation of the valley of the Pecos (b). But it is

Digitized by Google

soon observed endeavoring to resume its direct forthright, and before long is found in line with itself, so to speak, adopting the course of the valley of the Salado (c d). The Salado, I will also halt to point out, runs parallel to a certain line of heights which has been recommended as the natural boundary line between the United States and the North-east Provinces of Mexico (C D).

Reflecting on the significance of such a fact as the Rio Grande, you perceive how natural a thing it was for me to ask myself: Why should not a new route for a transcontinental rail way be discovered here—not far from the path of the great water way—through upper Mexico? This led me to examine, as I have said, the different passes or depressions of the misnamed Sierra, furnishing inclines leading up to the elevation of the Great Table. I looked for them into or through the Sierra, it is true, but comparatively near the river, where its elevation is diminished, and what is left of it is broken up. I am rewarded by having found two, and probably three, Passes, preferable to those heretofore recommended to the Engineer.

I am positive now that I can indicate the true line for the railroad, south of the Union Pacific, from the United States to the Pacific Ocean; and the best of it is that the short cut, B F, is the one which provides the most moderate gradients. From San Antonio, as your starting point, make your shortest cut for Mazatlan, and you will not be very far from either of these two lines.

The routes described in this paper both pass through the rich agricultural Laguna country, and through the richer Durango mining one, and are both singularly cheap of construction. Neither of them is deflected noticeably from the straight line, except as the Pacific is approached, where, to avoid engineering obstacles (less expensive ones, though, than those which the California Central R. R. has overcome), I recommend turning down into the State of Jalisco, through the northern part of the District of Tepic. There the Sierra Nevada, E F, coming from the north west, lowers as the East Branch of the Sierra Madre does in Northern Coahuila. To obtain a gentle slope without paying for it, I do not attack, but flank the Snowy Range.

Next in interest to these inter-oceanic railroad data (perhaps, too, after certain military questions unavoidably associated with the same) I should, perhaps, advert to the results of a visit to the country below the upper bend of the Rio Bravo, marked on the maps as Terreno Desconocido and Territorio Non Explorado. I thought it would be a rare field for original exploration, but it proved to have been well known to the Spaniards, who have left roads, military earthworks, mineral shafts, and other evidences of their presence there. The names of old Spanish settlements might be sprinkled over all this unoccupied space (x to y, and v to z). The correction of such an error as this should appear at least in our children's school atlases. I could occupy the evening in enumerating others, but will close with citing two hardly less striking. The *Bolson de Mapimi*, here, which covers so large a space on the maps, should properly be restricted to a

Digitized by Google

more limited area, north of the town of Mapimi. Mapimi, an old Spanish mining town, gives its name to a mountain near it, shaped somewhat like a big purse (Hispanicè *Bolson*). It appears to have been an after thought with geographers to lay down a figure of this shape, large enough to include a great reach of desert* plain. A similar correction should be made for the *Barrial de la Paila,* which is quite a narrow stretch of sterile plain lying on the west side of the *Sierra* de la Paila.

* * * * * * * *

II. ETHNOLOGICAL.

After a review of Humboldt's work in New Spain, closing with a eulogium on the great Explorer's thoroughness, General Kane proceeded:

But Alexander von Humboldt did not visit the Northern Provinces of Mexico. And I may say another thing without irreverence; he was not an ethnologist. In Spanish America, too, the persons who gave him most information in Natural History were priests or members of religious orders in the Roman Catholic Church. The minds of sincere persons in that communion have ever been fettered by the dogma that "God hath made of one blood all the nations of the earth," and they have seldom pursued ethnological research with zeal, never with impartiality.

I am sure that I do not overrate the value of Northern Mexico as a field for ethnological study. I can say emphatically of it that in this respect it is terreno desconocido; territoric non explorado.

It will be particularly interesting to us to seek the solution there of certain Historical Problems which have baffled our investigations.

In the Old World we have not been able to divest ourselves of the bias arising from our being in some manner or other parties to the discussion of historical questions. Each specimen of us belongs to some particular race or mixture of races, and, whether he has had a grandfather or not to take a pride in, if his self-consciousness but carries him back a single generation, he unites in feeling with those whom he thinks most like himself in mistaking what they accept as History for Science. Most of us in fact have a direct political or religious interest or feeling involved in our preference for deciding questions by the bulletin or historical pamphlet, rather than by the scalpel and craniological caliper. Prejudice should blind us less in Mexico. If we love our Dutch or Scotch, and hate our ancestral Spanish enemies, we cannot help unduly praising our Orange-Nassaus, and hating our Alvas; while we do not care enough to cheat much regarding the respective merits of the followers of Coanocotzin† or Ixtlilxochitl‡. An imputation on the standing of the Trinity, or the Virgin of the Immaculate Conception, may wound our feelings; we care nothing for theories ascribing greater or less exaltation to the gods Texcatlipoco,§ or Cu-at-li-cu-é.‖

In Northern Mexico, races have lived of the greatest variety of osteological structure. They have left, and they are now depositing in profusion,

* *Desierto*, Desert, not necessarily meaning uninhabitable desert.

† Texcocan enemy of Cortès.

‡ Texcocan friend of Cortès.

§ Of Heaven

‖ Of Flowers.

Digitized by Google

most interesting crania, simple and composite. Nowhere probably in the world are so great a number of healthy, full-grown youths, of known habitat and pedigree, meeting with violent deaths, and leaving their bones at the command of the collector.

Over Northern Mexico, and through it, in times bygone, have passed successive migrations of races, as remarkable as those which have occurred in our own historical period in Asia and in Europe.

And, alas, of the conquest of the weak by the strong, of that which you and I, Mr. President, if alone, must maintain to be the *Survival of the Unfittest*, of the conquest of peaceful, industrious and civilized races by warlike ones, Mexiço affords us at least two distinct and notable examples. Not less than two great invasions have proceeded directly from Northern Mexico, or passed through it. All the American conquerors of Central Mexico that we know of came from the North. We can study them in Northern Mexico as they existed before they removed South. It is an important point I make, that our researches in Mexico may be conducted in a strictly scientific spirit, free from the disturbing influences of partisan literature.—Of what nation is not the literature without force, if its tone is not (regarded in a philosophical sense)—provincial and partisan?

Again, the singularly favorable political anarchy now prevailing in Northern Mexico should be of the greatest service to the student. Seventy years ago the Spaniards governed New Spain. Not only their military sway (though, as I have intimated, it surprises the traveler every day how far out into the North they carried their military roads, their presidios, soldiers and cannon), but the dominion also of their laws prevailed, and their social customs, with their language and religion. Since the removal of the forces which maintained law and order, the whole of this régime has ended, or is coming to an end. The mental and moral characteristics of each native stock are seen to be re-asserting themselves. You can detect, with corresponding physiological varieties of structure, what manners the several species, sub-species and varieties were originally prone to, what laws naturally suited them, what religion. In truth, straight out before your face, and inconveniently to the purpose if you are in their way, they disclose what other species of men they are predestined to hate, and refuse most ferociously to live with on terms of amity.

To a certain extent an invading movement from the North upon more Southern Mexico is going on at this moment. I had a peculiarly favorable opportunity for witnessing an instance of its operation on a small scale.

I obtained an invitation at Piedras Negras to accompany the column of Government troops which moved upon Monclova and San Buenaventura in November last, and I made the most of my good fortune.

I had Don Pedro Valdès, the Military Governor of the district of the Rio Grande, and Colonel Ferdinand Montragon, his second in command, with me all the way. As far as Monclova my mess, my tent, my ambulance were theirs; one or other of them hardly left my sight. They knew personally a large number of their soldiers; whenever any one attracted my

Digitized by Google

attention as a subject of study, and they could not answer my questions regarding his name, birthplace and genealogy, they ordered him up to speak for himself. They became honestly interested in some of my ethnological guesses, which they esteemed shrewd, and, I honestly believe, went beyond politeness in giving extension to my inquiries. I think I pretty faithfully studied over 300 equestrian men; nearly all who were not of native Indian blood being Mestizo. Should I not at some future day recur to this subject, let me dispose of it by saying that, with traces of nearly every race whose abode has been the Iberian Peninsula, Basque, Jew, Zingaro even, the predominant Spanish element apparently was Andalusian. I could not at all guess how many kinds of native Mexican entered into the medley. My companions could distinguish many more than I could. A captain from near Bustamente, where there is an interesting ancient colony of them, could point out every Tlascalan in the crowd. But this I did see plainly myself, a large majority of the fighting *riders* were of the stamp of our own South-western warlike Indians. I am very familiar with the physiognomical characteristics of the Arrapahoe, Kickapoo (Qu. chica puta?), Ute and Sonora Apache. I lived some time among the Shoshones, and may be trusted to detect the Comanche wherever it occurs. I found the Comanche through Valdès' command in force.

The small-sized photographs which I place on the table were selected by me, chiefly from an army officer's collection, as being striking likenesses of men termed Mexicans, and regularly enrolled as members of Valdès' National Guard. If they were dressed up in the pictures as Christians, I have no doubt the subjects and their friends would have great pleasure in recognizing them. On the face of each photograph you will find the Indian name and tribe, on the back the Mexican.

The other photographs support views advanced by me in former, now nearly forgotten, communications.* The notes endorsed upon them will I think repay perusal.

a. Affords an interesting example of Atavism: the *back leap*, as the Spanish term it. The mother, a Mexican woman whose family style themselves Spanish, acknowledging only one sixteenth of Indian blood, is convicted of the Sambo or Chino by its reappearance in her daughter, an engaging and estimable young lady who is quite a dark mulatto. Fig 1. Her sisters, 2, 4, 5, 6 exhaust the shades of the segar box.

b. and c. Exemplify strikingly the persistence of the type. The German girls in b. were captives from their youth, very hardly used up to the age of puberty, when they were rescued. c. was more tenderly nurtured, being a head chief's favorite daughter. They are tame; she remains wild —*fera naturæ*.

*On Rank and Merit depending on lineage among certain (North American) Indian Tribes. 1847.

Lavater + Daguerre. 1848. Replies to Nott and Gliddon. 1850–1852.

Differences in the Results of Emancipation in the British West Indies corresponding to differences of Race observed there. 1853.

Idiosyncrasies of the Lucumis Gangas and other Bozales in Cuba. 1857.

The Application of Ethno-Physiognomy made by Mr. H. H. Slatter. 1856.

Digitized by Google

d. A family of German descent, exposed as partly Chino Mexican. The bony framework of the subjects not having been modified; the physiognomy, due to the integuments, is common to all the children, but the elder sister's face (2) is darkened by a shade of pigment in the mucous coat. In 1. and 4. it is said to be detectable in the *luna*.

The working of our little Invasion was about this: Valdès' army was made up, certainly more than half of it, of men of Northern Indian blood. They were moving south. Some of them might return, perhaps not many. When the company of Saragossa was marched off from that place, I saw a crowd of their women assembled to weep and wail over them in half Indian style, as if it were about to prove their last farewell. Other recruits who had left the pueblo under similar auspices had not returned. Their fate had been to die in battle, or of disease, or of the effects of wounds and exposure—or to embrace permanently the military career, in which case the élite of them found employment as regulars in the City of Mexico, or elsewhere in the provinces not far from the National Capital. The average man thus, after directly killing or contributing by impoverishment to starve a given number of the more industrious and peaceable members of races of the South, would become a southern resident, and leave descendants of his own, South, who would be half Northern and half Southern; that is, it might be, half warlike and lazy, half industrious and inoffensive.

Esteeming it a compliment to have been invited to express my opinions upon the political condition of Mexico at this interesting juncture, I will not consider it beneath the dignity of Science to notice the subject from an Ethnological point of view.

The North, as well as the rest of Mexico, presents a clearly marked case of ARRESTED NATIONAL DEVELOPMENT. The natural tendency of the different populations of Mexico to unite in one having been interfered with three centuries and a half ago by an outside pressure, and this pressure having been withdrawn, its effect upon the national life is now seen to have been unfavorable. Not only the political health, but, to persevere in the use of my figure, the existence itself of Mexico as a nation is menaced. The thoughtful observer is left in doubt whether, for the welfare of the people of Mexico, a synthetic or a further analytic treatment of their confederacy is most demanded. The former may be premature, the latter, now going on so rapidly, risks being carried too far. Many honest thinkers are of opinion that it would be beneficent to restore the foreign pressure, or an equivalent for it. In my opinion it would be but a reproduction of the original evil.

With your indulgence I will enlarge upon this theme, for brevity and to avoid confusion soliciting you to restrict the application of my remarks of a general nature to the Central Table Lands, of which we may popularly speak with least inaccuracy as Mexico.

At the epoch when the Wars of the Roses, Welsh wars and Scotch wars were preparing for Great Britain a United England; when the various elements already united as Gascons, Bretons, Picards, Normans were con-

Digitized by Google

tending which should form the future France; when, — less effectually as it has proved, because the ethnological differences involved were greater, — the different populations of Spain and Aragon, Murcia and Granada were fighting out whether they should absorb or be absorbed in the kingdoms of Castile and Leon, the different native tribes of Mexico were at the same work in their own way.

They were very numerous Geiger says, "There were at the time of the conquest and there are now, more than thirty different races, speaking as many different languages and marked by distinctive peculiarities." (p. 317.)

Our standard authority Humboldt's remarks are, "The great variety of languages still spoken in the Kingdom of Mexico proves a great variety of races and origin. The number of these languages exceeds twenty, of which fourteen have grammars and dictionaries tolerably complete. * * * It appears that the most part of these languages, far from being dialects of the same (as some authors have falsely advanced), are at least as different from one another as the Greek and the German, or the French and the Polish."

Humboldt mentions the Mexican, Otomite, Tarasco, Zapoteco, Misteco, Maya, Totonac, Popolouc, Matlazing, Huastec, Mixed, Caquiquel, Taraumar, Tepehuan and Cora. To these, the Mazahua, Huave, Serrano, — and, well, say a dozen others may safely be added. How many of these are derived from the primitive Nahuatl, neither this, nor in fact any other abstruse philological question, am I qualified to discuss. Enough here that my own observations lead me to place the number of separate tribal societies very high. But at the date of the Spanish conquest they were in a fair way of coalescing. With various ins and outs, and ups and downs, there can be no doubt that a process of consolidation was going on in Mexico through the thirteenth, fourteenth and fifteenth centuries, corresponding to that observable in Europe during the same period.

The Toltecans evidently had absorbed many tribes before they were succeeded by the Chichimecas, whose own absorptions constituted the monarchy of Tezcuco. Tacuba or Tlacopan had a similar history. So had the Aztec Kingdom or Empire, with whose history we are perhaps most familiar, the one ruled by the Montezumas. The original Aztecan divisions of Tlaltelolcos and Tenuchcas are mentioned to the traveler at this day, when his guide points out the ground they severally occupied upon the site of the present city of Mexico. These only united to form the Mexican monarchy in 1438. But by the beginning of the sixteenth century, Tlacopan, Tezcoco and Aztecan Mexico were practically united in one Confederacy. I cannot see how there is any room for question that the League had become a single nation, powerful enough to absorb all minor ones—outside of the Tarascos, and those Guastecos, who in Tamaulipas, under Cortina, are giving Texas so much trouble at this time. There survived, it is true, a few small independent nationalities. There was the priestly government of Cholula, and the moderately warlike kingdom of Aculhuacan, and the

Digitized by Google

Republic of Huexotzingo, and the stronger Republic of Tlascala, which was fighting for its independence against overpowering odds, when Cortez arrived barely in time to save it. Mr. Prescott has no authority for saying that the more widely the Aztec Empire was extended, the weaker it became. On the contrary, Mexico, under Montezuma II was as much a homogeneous nation between the Atlantic and Pacific for ten degrees of latitude, as Spain was then from the Mediterranean to the Pyrenees; more than England was from the Channel to the Highlands of Scotland.

I like to use dates when I can. In Europe we have 1519 as the year of the accession of Charles V in Germany. Three years before, the Fleming had become King of Spain. Four years before, Francis the First had become King of France. Ten years before, Henry the Eighth had ascended the throne of England. But in the spring of 1519 Hernando Cortez wooed his Malinche Marina in Tabasco and sailed with her to Vera Cruz. He entered the City of Mexico a conqueror, August 13, 1521.

With the effect of the European element introduced by Cortez you are familiar. The complete disintegration of all indigenous national combinations went with the extension over the Grand Mesa of the Spanish arms, laws, religious and social usages. We may safely speak of the Spanish rule as having continued absolute for more than two hundred years.

When, towards the close of the last century, the ethnological differences prevailing in Spain asserted themselves anarchically there, surprise is expressed at the slowness which her colonists evinced in throwing off the yoke. It was an uphill business in Mexico, and was managed there in the old time Spanish way—by men almost exclusively of Spanish blood. Their movement was not apprehended by themselves to be anarchical. They, at least thought that their cause was that of order, union and religion.

Hidalgo was a Spanish curate. Take his date as 1810. He was caught (where I came near coming to grief myself) at Bajan, in Coahuila, March the 21st, 1811, and shot the following 1st of August.

Matamoros, the curate of Jantetelco, was shot August the 3d, 1814, Curate Morelos, December 21st, 1815, and Mina, November 11, 1817. Yturbide proclaimed the Plan of Iguala February 14, 1821, and concluded the Tratados de Cordoba with Don Juan O'Donoju, September 27, 1821. Everyone of these champions of independence except Morelos, was clear Spanish, and the cry of the triumphant liberating army of the Three Guarantees I believe faithfully expressed the feeling of what was then still subsisting a Mexican Nation. The motto was borne on the tri-colored flag which the nation united in adopting. It was "Religion, Union and Independence."

Naturally we Americans have a prejudice against Yturbide because he had himself crowned Emperor in a cathedral, and perhaps because his family lived among us in their adversity, making themselves too familiar with us, particularly here in Philadelphia. But there was prob-

Digitized by Google

ably a good deal in Don Agustin before his head was turned. He had some excellent and faithful men, too; and under him, or some of these, his nation, I think, might have hammered its music out. In my judgment, the Mexicans have always acted foolishly in imitating ourselves and the French. Their establishment of a Federal Government, October 4, 1824, with a constitution affecting to be more or less a copy of our own inconsistent binate one, was a mistake. But in the end, under it, or something like it, they could possibly have made things work. But they have never had a fair chance. Their country was too rich to be let alone.

Before they could set their first government in running order, foreign invasion, and threats of foreign invasion, compelled them to pay exclusive attention to their foreign instead of their domestic affairs. It threw into the background men of learning and men of moral worth, and brought forward the more brutal sort—the *hombres de armas*—men of the horse and of the sword—the curses of Mexico. These men were required to defend the people from those who should have given them common interests, but only gave them a common enemy.

Indulge me, if you please, in a little more chronology.

The gravest of Mexican errors, the expulsion of the Gachupinas, was brought on directly by the threat of Spanish invasion.

Not a year after the last Spanish troops embarked from Vera Cruz, November 18, 1825, the Padre Arenas conspiracy was under weigh.

Barradas' expedition actually landed in 1829.

Our colonization of Texas, under Stephen Austin, had begun early in 1828. Edwards' effort at revolution came off there, if I remember, the year before.

In 1832 our Texans united with Santa Anna in pronouncing against the government of Bustamante, and defeated the Mexican troops with loss. In 1833 they separated from Coahuila.

In 1835 and 1836 they—I had better say *we*—fought the Mexicans in Texas. We—our Government—formally acknowledged Texan independence in 1837.

1840 is the date of Ben McCulloch's Texan Ranger fight.

1841, 1842, 1843 are the dates of our expeditions against Santa Fe and Mier.

In 1844 President Tyler concluded his Treaty of Annexation with the Texan Commissioners. We admitted Texas into the Union December 27, 1845; fought our battles south of the Rio Grande in 1846–1847; patched up our so-called peace in 1848.

We were hardly done with the Mexicans then before the French were at them a second time with their *Reclamacion de los Pasteles*—"their Pie Claims," as the Mexicans call them. I omitted to mention that in 1837, at the time when we acknowledged the independence of Texas, France was bullying Mexico about these Pasteles—claiming damages for pastry-cook's trays and the like, to the tune of $600,000. In 1838 she had shown us, with a fleet of eleven vessels, how easy it was to humble Mexican national

Digitized by Google

pride, by taking the old fortress of San Juan d'Ulloa. How France went on after this, giving the Mexicans no peace, is the history so familiar to us of the famous Intervention.

The Mexicans had France, Spain and England together upon their backs by 1861. Bazaine did not evacuate Mexico till 1867.

Certain political wounds are too green for me to say what I think of the course adopted by the United States after this.

I am unfortunate enough to entertain the conviction that in morals we are responsible for a great deal of the wrong which has been done. Breaking off abruptly, I should beg you to pardon my apparently meaningless digression. I am not confident that I have made out my case, but I felt bound to put in a plea for my Mexican friends who appear to you inexcusably engaged in the business of national suicide.

So very few of our good men have ever met them, the Mexican good men and gentlemen, when the Erinnides were not pursuing them! I stand almost alone in declaring that I know them as uniformly courteous, and generous, and brave—worthy to be the sons of mothers who, rich and poor, gentle and simple, afford the world some of its fairest examples of devoted tenderness and saintly piety.—Admit that they seem to be given over to the Furies. If they deserve our censure, they are entitled to our pity.

This said, I will return to what I think indisputably true. The history of Mexico for the last half century is that of the resolution of a population more and more into its constituent elements. The different races have asserted themselves, or have been used by the various politicians to enforce their pretensions. Some of these fellows have been strongly backed, perhaps by the remnant of a former ancient confederacy or union of several tribes having similar ethnological characteristics ; others have appealed only to the interests of single tribes or half tribes, as insignificant as the following of the ten-vote repeater who traffics for office on our State House Row. The same phenomenon, the thought occurs to one, is seen in every country, but it looks uglier where it is associated with the direct employment of physical force. Running up from Acupulco, in 1857, I saw "the Southern Tiger" Alvarez. A straight-limbed old Indian—not a trace of Spanish was discernible in him or any of the squaws decked in French dresses who constituted his dusky harem. King of Guerrero his flatterers called him. Before the Conquest he would probably have been King of Michoacan. He might then have fought a Moctezuma. In our times he fought and overcame a Santa Anna.

Alvarez would have been at either epoch neither more nor less than Head Chief of Tarascos.

I will take a second example from the other extremity of the Republic. Tamaulipas on the Gulf of Mexico is another renowned nursery and cradle of Revolutions. It is a unit in politics. If a Mejia has it, he is as sure of his following as a Bayard in a southern county of Delaware. Only, its warriors do not turn out to vote. They follow him with horses and arms, and expect him to supply them with ammunition. Tamaulipas is popu-

Digitized by Google

larly spoken of as a State. It is regularly divided into three districts—del Norte, del Centre, del Sur—and sends its nominal representatives often to the Federal Capital. But it is nothing more nor less than the old country of the Guastecos, which was imperfectly subdued, even by the Spaniards in their day. And Tamaulipas too has its Head Chief now, a Major General, and Lieutenant General, and Excellency, Governor Supreme, and so forth—Cortina. And Cortina is all and singular, gold lace and epaulettes included, just about the blood thirstiest savage existing on the Continent.

What have we to study in Mexico ethnologically, besides the descendants of the primitive inhabitants? The Gachupinas? They are better studied in the land of their derivation. What else then for the study of the ethnologist in Mexico? Alas! The Mixtures. Nowhere is there presented a greater variety of these than in Mexico. Every proportion of every variety of Spaniard; with every proportion of Indian, Mediterranean man, Moor and Negro. Nothing can be more distasteful to the inquirer who desires a simple study, than the variety of mental and moral characteristics which we find in the Mestizoes is associated with their diversity of physical constitution.

Among the mixed breeds the difference in the proportion of the characteristics derived from the different ancestors introduces anarchy into social circles, into the family itself. The appetites, the passions, the powers, the higher aspirations of one child are impatient of, are directly hostile to those which contribute in a different proportion to form the character of another. Here then, among the people of mixed breed is the Debatable Ground, the field for the intrigues and machinations of the designing politician. The typical politician of Mexico is himself the result of a mixture. He is restless, because the different elements in him vary his desires and aspirations. They are not the same at different periods of his life, are modified by the company he is keeping. He is inconsistent, when the medium in which he lives undergoes change. He lies, perhaps for the same reason that he is inconsistent. He is deliberately perfidious even, and then is the last man on earth to know how little he is to blame for being so. Who is to blame for his ferocity combined with gentleness, for his mingled generosity and ravin, his instincts of high honor united with deceit; yes, with revolting treachery. The answer is, the man who is responsible for his being the mixed man that he is; the Spaniard who was his ancestor is the culprit, who basely mated with the Indian woman from whom the Indian part of him is derived.

We have a distinguished Professor of Princeton proposed for membership to-night, whose ripe scholarship the Society will doubtless honor with the tribute of an election. There are members of the Society on the floor before me who believe (and they are entitled to their belief, though it is not my own) that there is an *Ultimate Philosophy* which will harmonize all knowledge with Religion. Indeed, I know that there is one, my valued friend, who goes so far as to entertain the conviction that Theology is entitled to be

Digitized by Google

ranked among the Exact Sciences. To such I would turn, and, adopting the terminology of that imposing study, would indicate the value of Northern Coahuila as a Hell where we can study faithfully what Sin means. We need be at no loss there for examples, for proofs that the sins of the fathers are visited upon the children—and that, beyond the third and fourth generations.

The splendid conqueror still dazzles our eyes as he flashes across the page of history. We realize how *chiquard* it seemed to many a young Spanish noble of pure blood to follow in the footsteps of Hernando Cortez, to carry about or be carried about by, to lead or be led astray by his Malinche—but we have come down to the end of that nice business. The dreadful end! The savage Indian would not now be re-asserting his savage characteristics, but for the aid lent him by the Devil working through the illegitimate descendant of the Spaniard. There is no mistaking it; it is the Red Savage—the old Adam—*terra rubra* there, out upon the warpath. The Spanish military rule first overthrown, he has subverted the civil order which it sustained. For the law which the Spanish introduced (a stately system not unworthy of its Latin origin) he prefers, perhaps on the way to re-introduce ancient barbarous and local usages, the momentary will of the last chief under whom he has fought as a brave (bravo) in battle. The language, for the birthright to use which all Christendom envies the Spaniard, he is expelling from the country by debasing it more and more with his native Indian below standard. Finally, he is destroying the last bond which holds the peoples south of the United States together, their religion. Under Juarez, who faithfully merited his surname of El Indio, and his successor, Lerdo, the persecution of the Catholic Church has been successful in eradicating true religious feeling to an extent which, before my last visit, I could hardly have believed possible. Among the ruling politicians in the north, I did not meet one man who, in conversation with me, did not proclaim himself superior to "Superstition." The authorized school books, in the miserable attempts at public schools, taught Huitzilopochtli (alias Mexĭtli),[1] Melantiuctli,[2] Tezcatzoacatl,[3] and the glories of Netzahual-coyotl[4] and Cuahtemoc.[5]

These be thy gods, O Israel!

There were old Spanish churches left, many of them not yet fallen to ruin, into which occasionally glided a few women muffled in black shawls, with their little children. Then a proscribed man might skulk in, perhaps, through a little door under the altar, and don for the mass priestly vestments which he was not allowed by law to wear outside the church. But the building you would find did not belong to him, but to the State. He could not, nor could any religious corporation, own property as religious societies do in the United States. If the Spanish bells in the tower were not melted down, he had no right to ring them; not to announce fair daylight to the sick-bed, not to bid an Angelus tell the laborer that it was

Gods—1. Of War. 2. Of Hell. 3. Pulque. 4. Tezcocan King, d. 1436. 5. Enemy of Cortez, d. 1525.

Digitized by Google

noon, not to sound a Vesper to "regret the dying day." But in the very midst of his murmured masses, in the crisis of the elevation of the Host itself, he might be interrupted by ruffians rushing in to ring a peal of their own, upon the receipt of news of some murderous victory, real or pretended.

In two skirmishes, so-called "battles," which I was regaled with, the church was the centre of the fight. In Monclova the women ran out of the church when the firing began, as they might with us after service, from a gathering thunderstorm. This was Sunday, November 12th ult., about noon. N. B.—Remington (American) bullets whistled about their ears.

Hoc ab initio persuasum civibus dominos esse omnium rerum ac moderatores DEOS; eaque quæ gerantur, eorum geri vi, ditione, ac numine. * * * * His enim rebus imbutæ mentes haud sane abhorrebunt ab utili et verâ sententiâ. It was an exotic—the Roman Religion—an imported article; but it was the last bond left to tie a good many unhappy souls together. It is nearly worn through. The last strands are parting. In short, the way things are going on, ten years ought to be a generous allowance for Mexico to rehabilitate the worship of her indigenous Gods of Hell, and Pulque, and War, and the sanction of public human sacrifice.

A continuation of Researches among the Batrachia of the Coal Measures of Ohio.

BY E. D. COPE.

(*Read before the American Philosophical Society, February* 3, 1877.)

The material described in the following pages was obtained from the coal strata at Linton, Ohio, during the Summer of 1876, by Prof. J. S. Newberry, Director of the Geological Survey of Ohio.

ICHTHYCANTHUS OHIENSIS. Cope. Gen. et sp. nov.

Char. Gen. These are derived from the posterior dorsal and caudal vertebræ, with adjacent parts. Posterior limbs well developed, with distinct tibia and fibula, osseous tarsus, and probably five digits. Ribs elongate, simple, curved. Abdominal armature consisting of bristle-like rods in anteriorly directed chevrons. Dorsal vertebræ not elongate, with simple neural spines. Tail large, its vertebræ ossified, and furnished with slender chevron bones which terminate in a hæmal spine. Neural spines slender and directed backwards; the caudal series somewhat resembling that of a fish. All the centra amphicœlian.

This genus differs from all those with enlarged and sculptured neural spines, and from those with abdominal scuta. It is equally distinct from those without ribs, abdominal rods, or limbs. It is possible that some of the species referred to *Tuditanus*, in which these parts are unknown, may belong to it, or that it may be established on a small species of *Leptophrac-*

Digitized by Google

tus, a genus only known as yet from cranial remains. With present knowledge the reference of the *I. ohiensis* to the latter genus is inadmissable. The cranium, thoracic region, and fore-limbs of *Ichthycanthus* are unknown.

Char. Specif. The centra of the dorsal vertebræ are about as long as deep, and their sides are deeply concave: there are four anterior to the pelvis which are without ribs. The caudal vertebræ are robust, and seven from the first, support a small tubercule-like diapophysis. The chevron bones are short and acuminate; the neural spines are a little shorter, narrow and truncate, and directed backwards at the same angle as the chevron bones. They are much reduced on the eighteenth caudal vertebra, where the chevron bones are considerably longer.

The abdominal rods are quite slender. The hind limb is quite stout for this order. The femur is regularly expanded at both extremities, but the distal is deeply and openly grooved, distinguishing the condyles, while the proximal end is plane. There is no trochanter visible. The ulna and radius are well separated, and are three-fifths the length of the femur. There is a large *fibulare* tarsal bone of a subquadrate outline. In immediate contact with it is the probably external digit with five phalanges or segments; the ungual is simply conic. The femur is as long as five dorsal vertebræ. The ribs have expanded, undivided heads, and extend to the abdominal armature.

Measurements.	M.
Length of last ten dorsal vertebræ	.047
" " first twenty-three caudal vertebræ	.117
" " a posterior rib	.029
" " " dorsal vertebra	.005
" " twenty-second caudal vertebra	.005
" " femur	.025
Proximal diameter of femur	.008
Width of lower leg	.009
Length of fibula	.015
" " tarsal bone	.006
" " digit	.027

This salamander is about the size of the *Menopoma alleghenienses.*

Ichthycanthus platypus. Sp. nov.

This batrachian is represented by almost the same portions of the skeleton as the preceding species, furnishing a good basis of comparison. It is very well preserved, displaying the characters especially of the hind foot, which is almost entirely represented.

Several features distinguish it from the *I. ohiensis*, one of which is of more than usual value if correctly indicated by the fossil. There are ten vertebræ from anterior to the sacrum preserved in place, and none of them supports a rib, nor are there any ribs visible anywhere on the block of shale. I suspect that they exist on more anterior vertebræ, or may have been displaced to a more anterior position than they normally occupy.

Digitized by Google

The abdominal chevrons are more anterior in position than are those of the *I. ohiensis.* The hind legs are longer than in that species; in this one the femur equals seven and a-half vertebral centra in length. The external digit on the other hand, while bearing five phalanges, is distinctly shorter. The fibular tarsal is of a transverse oval, not quadrate, form.

The dorsal centra are short and deeper than long; the neural arches are elevated, with short but distinct zygapophyses, and a flat subquadrate, superiorly truncate neural spine. They bear short, vertically compressed diapophyses near the bases of the arches. The neural spines of the caudal vertebræ become rapidly more slender, and also diminish in length, while the zygapophyses are continued to the fifteenth vertebra, where the series is broken off. The chevron bones are slender, and enclose a moderate hæmal arch.

The femur is gradually expanded to the extremities Proximally there is a trochanteric ala besides the obtuse head. Distally the condyles are well distinguished, the external or fibular being truncate. The fibula is less than three-fifths the length of the femur, and is expanded at both extremities. Two proximal tarsals are distinct; the one next the fibula is larger than the other and transverse suboval in form. It has a median dividing ridge as though composed of the *fibulare* and *intermedium* coössified. The *tibiale* is subtriangular. There are five distinct phalangeal tarsals. The toes are in the order of their lengths beginning with the shortest, 1—2—5—3—4. Their phalanges (including metatarsals) are, in the proper order, commencing with the hallux, 3—3—4—?5—5; the distal end of the fourth finger being lost. These bones are rather stout, and the unguals are simply conic. The form of the foot is short and wide. The number of phalanges is nearly similar to that I have found in the *Amphibamus grandiceps*, excepting that in that species the fifth digit has but four. They are more numerous on most of the digits in *Sauropleura digitata.*

Measurements.	M.
Length of ten dorsal vertebræ	.045
" " fifteen caudal "	.055
" " the centrum of a dorsal	.0038
Total elevation of a posterior dorsal	.014
" of posterior of zygapophysis of dorsal	.010
Length of femur	.032
Diameter of femur medially	.0045
" " " distally	.0083
Length of fibula	.018
Diameter of fibula proximally	.007
Width of sole at second row of tarsal bones	.017
Length of foot to end of third digit	.031
" " first digit	.010
" " third "	.023
" " fifth "	.020

Digitized by Google

LEPTOPHRACTUS LINEOLATUS. Sp. nov.

This large batrachian is represented by the middle portion of a cranium, including parts of both jaws with numerous teeth. It is not easy to determine which of the tooth-bearing bones preserved is maxillary and which dentary, but the lighter and thinner of the two is presumably the latter, although it has the greatest vertical depth. The opposing bone supports two types of teeth, and as this is only the case in the maxillary of *Leptophractus obsoletus*, the present bone may be provisionally referred to that position.

There is a great difference in the sizes of the two types of maxillary teeth, the larger having nearly three times the linear dimensions of the latter. The small ones are rather distantly placed, being separated by interspaces nearly equal to their lengths. They are cylindric at the base, but become compressed, and have two opposite cutting edges on the apical third. They are of rather slender form, and are striate at the base. The longer teeth have a similar form, but are less strongly compressed distally, where there are two opposite cutting edges. The basal portion is quite closely striate. These teeth are on a different basal line from the small ones, since when their bases are removed the latter appear behind them. Three smaller teeth stand in the spaces between two large ones.

The mandibular teeth are intermediate in size between the large and small ones of the maxillary series, having a little more than half the linear dimensions of the former. Their terminal three-fifths are compressed, and furnished with fore and aft cutting edges.

The surface of the bone, where visible, does not display the punctate sculpture of that of the *L. obsoletus*, but is nearly smooth, displaying only fine parallel incised striæ.

Measurements.	M.
Depth of dentary bone at middle	.030
Length of mandibular tooth	.009
Antero-posterior diameter of mandibular tooth at base	.0035
Length of long maxillary tooth	.022
Antero-posterior diameter do. at base	.006
Length of small maxillary tooth	.007
Antero-posterior diameter do. at base	.002

The smaller size and slender form of the smaller maxillary teeth, as well as the peculiar sculpture distinguish this species from the *L. obsoletus*.

Another specimen of *Leptophractus* resembles the one above described in the form and disposition of the teeth, and has the osseous surface of both maxillary and dentary bones marked with shallow grooves and punctate impressions which do not inosculate. In this it resembles the maxillary bone of the large specimen figured on Plate XXXVII of the second volume of Paleontology of the Report of the Geological Survey of the State of Ohio.

Digitized by Google

TUDITANUS TABULATUS, Sp. nov.

This species is indicated by a specimen which includes a cranium, and the anterior part of the vertebral column. It is very well preserved on a block of shale, on both faces, and exhibits the constituent pieces of the cranium, the vertebræ, one of the thoracic shields with probable ribs. In all respects it conforms to the genus *Tuditanus* in characters; presenting a broad, flat head: osseous vertebræ and ribs; thoracic shields present, and abdominal chevrons probably absent. The last character is not absolutely assured, since the posterior two-thirds of the vertebral columns are wanting.

The cranium is wider than long, and the muzzle is broadly rounded. The orbits are wide ovals, and their posterior borders fall little behind the transverse line dividing the skull equally. The interorbital width equals the longitudinal diameter of the orbit. The posterior outline of the cranium is truncate in a straight, transverse line between the prominent epiotic angles. The distal extremities of the quadrates do not project so far backwards as the epiotic angles, and are still further removed from a transverse line marking the extremities of the occipital condyles. In this respect this species presents a strong contrast to the *Pelion lyellii*, where the ends of the quadrates extend posterior to the latter points. The composition of the superior cranial walls much resembles that of the *Tuditanus radiatus*. The epiotics are large bones, longer than wide, and present outwards strong angles, which correspond with the horns of *Ceraterpeton*. They enclose between them the posterior portion of the parietal, and the supra-occipital. The latter is a transverse bone, and not quite symmetrical in the specimen, one end having a greater antero-posterior extent than the other. The parietal is the largest cranial bone, is undivided, and is pierced by a median foramen behind the centre. Its general form is broadly wedge-shaped, the lateral borders expanding in front of the fontanelle, and contracting between the epiotics. The frontals are distinct and rather narrow. The post-frontals are rather large, are in close connection with the parietal on one side and the jugal on the other, and send a point backwards between the epiotic and supratemporal. The jugal widens fan-shaped backwards, joining two bones distally, a superior and an inferior. The former is the supra-temporal, but whether the inferior is quadratojugal or squamosal, I cannot determine. The boundaries of the bones of the extremity of the muzzle are not distinct.

The sculpture of the surface of the cranium consists of parallel ridges which are separated by grooves equal to them in width. The ridges radiate inwards on the epiotics and frontals, and outwards on the squamosal, and are transverse and interrupted on the supraoccipital. The lateral thoracic shield is covered with a similar sculpture of uninterrupted somewhat radiating ridges. The vertebræ are osseous, and rather small compared with the size of the skull. Opposite to the posterior extremity of the pectoral shields is a pair of slender bones, which are gently expanded and truncate at the extremities. It is not certain whether these belong to the

Digitized by Google

forearm, or are a pair of short ribs. Impressions only of the teeth remain; they indicate small pleurodont denticles like those of the *Anura*.

Measurements.	M.
Length of cranium above	.029
Width " "	.037
" between epiotic angles	.018
" of interorbital space	.007
" " orbit	.006
Length " "	.007
" " skull to fontanelle	.008
" " from orbit to nares	.005
" " " " " to end of snout	.003
" " lateral pectoral shield	.015
" " atlas	.004
Width " "	.004

This species of *Tuditanus* differs from the *T. radiatus* in the larger and less anteriorly placed orbits, and in the large truncate posterior table of the skull. The proportions of the latter are more those of *P. obtusus*, but the epiotic angles have not been observed in this species, the sculpture is punctate not linear, and the form of the supraoccipital is quite different. Comparison with the other species referred to that genus is unnecessary, excepting in the case of the *T. mordax*. Further examination of the specimen on which the latter was founded leads to the belief that it is an imperfect cranium of *Ceraterpeton punctolineatum* Cope. The latter name, as the preferable one, may be adopted, and the former becomes a synonym.

COLOSTEUS SCUTELLATUS, Newberry; Cope, Rept. Geol. Surv. Ohio, Paleontology Vol. II, p. 407.

Another specimen of this species was obtained by Prof. Newberry during the past season, which includes some parts of the skeleton not previously observed.

The specimen presents a superior view of the ventral and thoracic protective armature, and of the posterior portion of the cranium. As heretofore, I find no indications of vertebræ, but along one side of the ventral scutellation, a series of slender ribs lies in the matrix. These I have not previously found in this genus. The cranial surface is only preserved on the lateral portions. Its sculpture consists of coarse grooves closely placed, directed outwards and forwards.

Digitized by Google

On a Dinosaurian from the Trias of Utah.

By E. D. Cope.

(*Read before the American Philosophical Society, February 16th, 1877.*)

Dystrophæus, Cope.

This genus reposes on scanty remains, but which are in good preservation, and which present marked characters. The bones consist of the humerus, three metatarsals, some ? tarsals, and the distal end of an ? ulna, with a probable sternum and an inferior element of either the scapular or pelvic arch, probably the latter. There is also a number of fragments, which are not easily identified. The specimens were discovered by Prof. J. S. Newberry in South-eastern Utah, while acting as Geologist to the Engineer Exploring Expedition under the command of Captain McComb, United States Army, He excavated them from the red and green rocks usually referred to the Trias, hence from the same formation which yielded the *Typothorax* already described. Professor Newberry made sketches of the bones as he exposed them. They were all, he states, found in close proximity, the bones of the limb in nearly normal relation. It is altogether probable, according to Professor Newberry, that they belong to a single animal. I find nothing to forbid this supposition and much to confirm it.

One of the most remarkable bones is a broad, flat element, one of whose borders is digitate, the processes being long, and separated by deeply entrant sinuses. Two sides of the bone are broken away, but the others give origin to five digitiform processes. Two of these are larger and longer than the others, and externally on the right side is a shorter one. Outside of this is a larger process whose extremity is recurved so as to be subparallel with the longer processes, and which was connected with another bone by an articular surface. This information is derived from Prof. Newberry's notes made in the field. It is probable that this bone is the sternum, and that the articulation mentioned is costal. It is not certain whether the longitudinal meridian line passes through a sinus or a digitation, but a projection of the surface of the plate, which is probably median, is opposite one of the latter. Supposing then that the sternum is produced into a median posterior process, we find a resemblance to the corresponding element in many birds not heretofore known among reptiles. There are in that case three postero-externally directed processes on each side, of which the two posterior are free. Another interpretation might be that it is a coracoid with anterior digitations. In this case the articulation above mentioned would be anomalous. The number of digitations is too great for this element, and the space remaining for contact with the sternum is too small.

Another large flat bone approximates a right-angled triangle in form, the length greatly exceeding the width. The right-angle is massive and

Digitized by Google

produced, and is evidently the point of connection with the other parts of the skeleton. The bone is flat on one side and convex on the other, and can only be identified with probability, with the scapula of a Dinosaurian reptile.

The large size of the anterior limb, which might be inferred from this scapula, is justified by the humerus, which is preserved in almost perfect condition. This humerus is one of the longest, and is distally the most contracted known in the *Dinosauria;* the proximal extremity is of the form usual in that order. A short distance below the head, the section is T-shaped, with one end of the transverse limb shorter than the other. The ridge of which this limb is a section, is almost wanting at the head, which is thus Γ-shaped. The limb representing the stem of the T is stouter than the others, and forms the summit of a massive column, which soon sinks into the shaft. Its free extremity is obtuse and rounded, and though representing the head, does not rise above the level of the other crests, or tuberosities. The distal extremity of the humerus looks much like that of a tibia. It is truncate, and its long axis is in the plane of the tuberosities of the head. Its outline is oval, one end narrowed to an angle, and the other broadly rounded. The surface is roughened with coarse pits.

The distal extremity of another long bone, most probably the ulna, is more robust than that of the humerus. The shaft is a flattened oval, and the articular extremity is a wide and somewhat irregular oval, the greatest transverse diameter being nearer one end. The articular surface is roughened with coarse pits.

Three metatarsals were found in immediate proximity to each other, two in nearly their normal relations, and one slipped forwards. They are neither remarkable for length nor abbreviation. The proximal ends are truncate, and the distal ones convex, but without distinct median grooves or lateral angles. Both extremities are moderately expanded, and the shafts are contracted at the middle. The external bone is a little shorter than the two others, and is more flattened. It has a slightly-defined convex head, with an adjacent prominent, but ill-defined, lateral crest. The larger of the longer bones has a crest at one angle, like that of an olecranon process. The proximal end of the same bone is massive, and is trapezoidal in outline; the outline of the corresponding head of the adjacent bone is triangular. A marked character of these bones is the rough or pitted surface of their articular extremities, except the distal end of the shorter bone. The shafts are solid, and filled with nearly equal, coarse cancelli.

The bones above described are evidently those of a Dinosaurian reptile, and they present characters which have not been previously observed in any other genus of the order. The form of the condyles of the humerus distinguishes it from the other known genera, especially from those of the European Trias, where the crest is weak or wanting.

The rugose articular surfaces are also peculiar, indicating less than the usual mutual movement of the bones upon each other. A cartilaginous cap is indicated, which was probably the element from which the mam-

Digitized by Google

malian epiphysis was derived. The sculpture of the surfaces is coarser than that to which epiphyses are attached in the *Mammalia*. The name of the genus expresses this character.

It is altogether probable that this genus embraced terrestrial animals, with powerful fore- and hind-limbs subequally developed. The typical species is of gigantic proportions.

DYSTROPHÆUS VIÆMALÆ, Cope.

In the supposed sternum of this animal (which I have not seen, but which was sketched by Professor Newberry), a rather small, slender and compressed process projects from near the middle of one of the sides at right angles to it. Only two of the lateral processes are represented as complete. The longer is subspatulate; the shorter subacuminate. The scapula presents three complete borders,—the proximal and two lateral; but the distal is not known. Without it, the length is two and one-half times the breadth. The point of junction of the longer (and perfect) short border with one of the long borders, is much thickened, terminating in a mass of bone which is unfortunately broken, but whose section in the line of the end border is a wide oval. From this point, the plate thins away to the various borders. The greatest thickness is nearer the border which terminates in the enlargement described. This surface is then gently convex in transverse section, while the opposite one is concave to a less degree. It is thicker at the middle than at the anterior border in a longitudinal direction.

The proximal extremity of the humerus is much expanded. The greater tuberosity is a huge crest, as prominent as the head, and separated from it by a marked concavity which constricts the mass connecting it with the head, thus forming a neck. This concavity extends about one-third the length of the shaft. On the opposite side of the head a similar concavity excavates the shaft, separating the internal from the interior ridge. The latter is in its middle portion as prominent as the external ridge, and extends as far downwards. The extensive external face of this part of the bone is nearly flat.

The internal ridge descending from the head, continues into the posterior border of the interior face of the shaft. The great tuberosity continues into the single external ridge of the shaft, which is thus near the middle triangular in section, the base of the triangle internal. The external extremity of the distal end is therefore an angle, and the internal a convex side, shorter than the anterior and posterior sides. A ligamentous groove marks the posterior border of the extremity at a point measuring one-third of its length from the external angle. The expanse of the distal extremity is not more than three-fourths that of the proximal. The entire bone so resembles a tibia, as to have induced me to refer it at first to that element. The characters of the proximal end are such as to render such identification highly improbable. Such reference would also require that the distal extremity should have a fore and aft direction, an arrangement incompatible with the tibia.

Digitized by Google

The displaced metacarpal is flattened, and expanded at the extremities. One side is nearly flat, but slightly concave in the longitudinal direction: the other side is convex and nearly level in the longitudinal direction. The lateral borders of the shaft are thus narrowed. The distal end displays a convex condyle, and a flat, prominent ala, which is in the general plane. The ala is separated from the condyle by a deep groove on the convex side. The condyle is a half-hemisphere only, presenting only with the convex side of the shaft, from which it is not separated by a constriction. It is bounded at its distal edge by an angle, which is a continuation of the proximal edge of the ala. The proximal extremity is injured at one angle, but, with this complete, would be nearly a regular rhomboid with parallel longer and shorter outlines; the acute angle of the latter being the continuation of the lateral border of the shaft. The extremity is subtruncate, and part of the surface is irregularly excavated by pits and grooves. The transverse extent of the proximal end, when perfect, was probably a little greater than that of the distal.

The two adjacent metacarpals are subequal in length, and longer than the displaced one by one-fourth the length of the latter. One of these bones is throughout rather thicker than the other, although the transverse diameter of the shafts is equal; but the stouter bone is considerably more dilated at the extremities. The distal end of the stouter bone is thickened in the direction at right angles to the plane of the limb; but the chief expansion is in that plane. The angle next to the other bone is protuberant, while the other angle is expanded into a sharp, convex crest, or ala. A section of this extremity is diamond-shaped, with one of the lateral planes produced into this crest, while the corresponding border of the opposite side drops down, being represented by a mere convexity of the surface which continues to the crest. The surface of the extremity is irregular. The section of the shaft is a broad oval, becoming subcircular near the proximal extremity. The latter is enlarged in both directions. It is a rectangle in outline, a little extended in the plane of the limb, with one of the angles cut off from the corresponding angle to the middle of one side. The long side thus left is slightly convex, and ends in an angle. The side subtended by this angle is slightly concave, and is approximated to the other bone. The opposite side is slightly emarginate near the middle. Its surface is very slightly convex, and is irregularly grooved and pitted.

The more slender of the two bones is but little and about equally expanded at the opposite extremities. The distal end would have an ovoid section, but for the fact that it is obliquely truncate at the extremity next to the other bone. It is convex in the antero-posterior direction and plane in the transverse; its surface is grooved and pitted. The side next to the other bone is flat or slightly concave at the distal end, and, though thicker than the external border, becomes rounded at the middle of the shaft, and is again flattened at the proximal extremity. The external border is distally produced into an obtuse angle; lower down, the shaft has a thin, angular border. The proximal end has less antero-posterior diameter than

Digitized by Google

the distal, and is subtriangular in outline; the apex being acute and external. The surface is flat, and is strongly marked with deep grooves. The other surfaces of the limb-bones are smooth, except a few weak ridges near the distal ends of the two distal bones.

Measurements.		M.
Length of part of scapula preserved		0.680
Width at middle		0.270
Thickness at middle		0.048
Thickness at proximal angle		0.117
Total length of humerus		0.765
Diameter of proximal end	at head	0.080
	at tuberosities	0.225
Diameter of shaft	antero-posterior	0.080
	transverse	0.078
Diameter of distal end	antero posterior	0.085
	transverse	0.145
Transverse diameter of head of humerus		0.160
Diameter of extremity of ? ulna	antero-posterior	0.110
	transverse	0.150
Length of external metacarpal		0.210
Proximal diameter	antero-posterior	0.045
	transverse	0.100
Diameter of shaft	antero-posterior	0.033
	transverse	0.067
Diameter distally	antero-posterior	0.050
	transverse	0.115
Length of median metacarpal (stouter)		0.245
Diameter proximally	antero-posterior	0.057
	transverse	0.115
Diameter of shaft (transverse)		0.055
Diameter distally	antero-posterior	0.074
	transverse	0.088
Length of median metacarpal (slender)		0.240
Diameter of proximal end	antero-posterior	0.057
	transverse	0.089
Diameter of shaft (transverse)		0.049
Diameter distally	antero-posterior	0.041
	transverse	0.083

More than usual interest attaches to this fossil. It is the first one found in the Triassic beds of the Rocky Mountain region, and was derived from an inhospitable region rarely traversed by white men. The locality is in the Painted Canyon not far from the Sierra Abajo in South-eastern Utah, near the Colorado boundary; lat. 38° 15′; lon. 110°. This canyon is one of those tributary to the Great Colorado River, and is without water. The rock is described by Prof. Newberry as the same as that which I

Digitized by Google

have identified in New Mexico as the Trias, and is of the usual red color. The occurrence of a terrestial Dinosaurian at that locality tends to confirm the conclusion to which I have already attained, that this immensely extended deposit is of lacustrine character.

On a New Proboscidian.

By E. D. Cope.

(*Read before the American Philosophical Society, March* 2, 1877.)

I recently received from a correspondent in one of the Southern States, a fossil of unusual interest. It is a molar tooth of a proboscidian, whose color and mineral character indicate that it was derived from beds of the Upper Miocene or Loup Fork epoch. Its roots are largely broken away, while the crown is nearly perfect.

The crown consists chiefly of two transverse crests, which are separated by a deep uninterrupted valley. There is no general cingulum. Each crest is divided into three lobes, which are not deeply separated, but cause the edge of the crest to be serrate with three conic eminences. Of these the median apex has a rounder section, while the lateral are more transverse, rising at the external borders like the extremities of the crests in *Mastodon ohioticus*. The appearance of the base of the crown at one extremity indicates that it was in contact with the preceding tooth. The opposite extremity of the base presents no such surface, and hence points to the conclusion that the tooth is the last one of the series. From the middle cone of the anterior crest a cingulum descends on each side, passing round the anterior base of the external cones. It is wanting at the extremity of the base of one of these, and little developed on the other, but they reappear on the side of the base bounding the valley. They are crenately tubercular, except at the base of the median anterior tubercle. There is no cingulum at the base of the posterior crest, except the ordinary filling between the bases of the lobes. One of the extremities of the crests is a little higher than the other, and the basis is a little wider than at the other end ; it is therefore probably external in position. At the posterior base of this end is a fractured surface indicating a cingular tubercle of stout proportions, such as is more in place at the external posterior angle of the last superior molar than in any other tooth.

The external cone is defined from the median by a fissure, while a better defined depression separates the median from the internal. This depression is filled by a worn tubercle in the anterior crest. Ridges descend along the adjacent borders of the constituent cones nearly to the fundus of the valley, and the bases of the external ones are considerably wrinkled.

Measurements.	M.
Transverse diameter of crown	.130
Longitudinal " " internal	.070
" " " external	.090

Digitized by Google

Elevation of external cusp	.065
" internal "	.055
Length between apices of external cusps	.043

The molar tooth described exceeds in transverse dimensions that of the *Mastodon ohioticus*, and evidently belonged to one of the most colossal of land animals. Its generic position is near to *Mastodon* and *Dinotherium*, but if the tooth on which my observations are based be complete, it is distinct from either. The possession of only two transverse crests separates it from the former, and would, were the tooth an anterior molar, refer it to the latter. As it appears to be a posterior molar, this view of its affinity becomes untenable, and I therefore establish for it a new genus, under the name CÆNOBASILEUS. The tooth described resembles that of the genus *Tapirus*, but differs in the absence of the external trihedral enlargement of the cross crests seen in the superior molars of the former, and also in the tubercular and fissured character of the crests proper. The species may be called *C. tremontigerus*.

The typical specimen was probably obtained in Texas, but I am not yet informed as to the precise locality.

CONTRIBUTIONS FROM THE LABORATORY OF THE UNIVERSITY OF PENNSYLVANIA.

No. VIII.

On the Composition of the Natural Gas from certain Wells in Western Pennsylvania and New York.

By Samuel P. Sadtler.

(*Read before the American Philosophical Society, March* 2, 1877.)

In February, 1876, I read before this Society a paper giving some results obtained in the analysis of the natural hydrocarbon gases of Western Pennsylvania. The material examined at that time consisted of the gases from the Burns Well and the Harvey Well in Butler Co., from the Rogers Well in Westmoreland Co., and the Cherry Tree Well in Indiana Co.

During the past summer I was again engaged in the service of the Second Geological Survey of the State, and spent a month in the Oil regions of Pennsylvania. While on this trip I collected six new lots of natural gases and have recently completed my examination of them.

These gases were the following:

1. A new sample from the Harvey Well in Butler County. This was taken as in the previous case from the delivery pipe in Spang, Chalfant & Co.'s Mills at Ætna, Alleghany County, Pa. An interval of nine months had elapsed and I wished to see if any differences in its chemical composition could be made out as having occurred in the meantime.

2. From a Well near Sheffield Station on the Philadelphia and Erie

Digitized by Google

R. R. in Warren County. This well had yielded only a trifling amount of oil but from it came a terrific outburst of gas. The geological horizon was totally different from that of the gas-wells in Butler County, being at least 600 feet lower. The gas had been used for some time to light the town of Sheffield and the tanneries there, being conveyed in pipes some two miles for that purpose.

3. From a Well some five miles from Wilcox Station on the Philadelphia and Erie R. R. in McKean County. Two wells had been sunk in this neighborhood for oil and both had yielded gas only. The geological horizon here is again different being some 400 or 500 feet lower than that of the Sheffield Well. The gas is not utilized at present.

4. From one of the gas wells at Erie, Pa. Quite a number of wells have been sunk at different times in the city of Erie, and the gas obtained has been utilized as fuel in the manufactories there. The specimen taken was from a well sunk by Oliver Bacon & Co., and the gas was used by them as fuel for their flour mills. This gas is again from a distinct geological horizon.

5. A specimen taken from the old well at Fredonia, N. Y., which has supplied the town of Fredonia for a number of years with a natural illuminating gas, was taken for analysis and comparison with those from the Pennsylvania localities. This gas is from a depth of 100 feet only.

6. A specimen was also taken from a new Well at Fredonia, which is now used for purposes of illumination. This gas comes from a depth of 1200 feet.

These gases were all collected, as in the previous cases, in glass tubes which were sealed before the mouth blow-pipe, while a current of the gas was still passing through them.

I will present with these new analyses those of the other gases published in my former paper. This is chiefly for the purpose of comparison. For this same reason I have classified the gases in several groups according to their geographical location.

I. *Gases from the Lower Oil Fields.*

1. Burns Well in Butler County. Collected in November, 1875.
2. Harvey Well in Butler County. Collected in November, 1875.
3. Gas from the same Well. Collected in August, 1876.
4. Rogers Well in Westmoreland County. Collected in November, 1875.

	1.	2.
Carbonic Acid (CO_2)	.34	.66
Carbonous Oxide (CO)	trace	trace
Ethylene series (C_2H_4)	——	——
Hydrogen (H)	6.10	13.50
Marsh-gas (CH_4)	75.44	80.11
Ethyl-hydride (C_2H_6)	18.12	5.72
Propyl-hydride (C_3H_8)	trace	trace
Oxygen (O)	——	——
Nitrogen (N)	——	——
	100.00	99.99

Digitized by Google

	3.	4.
Carbonic Acid	.71	.35
Carbonous Oxide	.24	.26
Ethylene series	.06	.56
Hydrogen	5.60	4.79
Marsh-gas	85.40	89.65
Ethyl-hydride	7.96	4.39
Propyl-hydride	trace	trace
Oxygen	.03	—
Nitrogen	—	—
	100.00	100.00

II. *Gases from Warren and McKean Counties.*

1. Sheffield Well in Warren County. Collected in August, 1876.
2. Wilcox Well in McKean County. Collected in August, 1876.

	1.	2.
Carbonic Acid	.09	.02
Carbonous Oxide	.24	.15
Ethylene series	—	.62
Hydrogen	3.12	7.55
Marsh-gas	78.42	62.37
Ethyl-hydride	18.00	29.29
Propyl-hydride	trace	trace
Oxygen	.13	—
Nitrogen	—	—
	100.00	100.00

III. *Gases from the Lake Erie border in Pennsylvania and New York.*

1. Erie gas from Erie, Pa. Collected in August, 1876.
2. Older Fredonia Well. Collected in August, 1876.
3. Newer Fredonia Well. Collected in August, 1876.

		1.	
Carbonic acid		.30	
Carbonous oxide		.61	
Ethylene series		—	
Hydrogen		.43	
Marsh-gas	40.33	98.59	69.44
Ethyl-hydride	58.26		trace
Propyl-hydride	trace		29.15
Oxygen		.07	
Nitrogen		—	
		100.00	

Digitized by Google

		2.			3.	
Carbonic acid..........		.44			.28	
Carbonous oxide........		.84			.22	
Ethyline series.........		.42			.47	
Hydrogen............		8.56			7.49	
Marsh-gas......	40.83	89.73	65.28	26.99	91.55	59.27
Ethyl-hydride..	48.90		trace	64.56		trace
Propyl-hydride..	trace		24.45	trace		32.28
Oxygen.........		——			——	
Nitrogen........		——			——	
		99.99			100.01	

The hydrocarbons of the Marsh-gas series in these three analyses can be counted together with perfect accuracy as 98.59 per cent., 89.73 per cent., or 91.55 per cent. respectively, or we have a choice of two methods of reckoning the individual amounts, with proximate accuracy however only. In these analyses the second method of estimation, viz: that dividing the amount between marsh-gas and propyl-hydride appears the more probable.

IV. *Gas from Indiana Co. Pa.*

1. Cherry Tree Well. This gas bubbles through a spring of fresh water and had to be collected over water. The totally different circumstances of its occurrence will explain in part the differences in composition. The geological horizon is much higher than that of any other gases analysed. It was collected in November, 1875.

	1.
Carbonic Acid....................................	2.28
Carbonous oxide..................................	——
Ethylene series..................................	——
Hydrogen...	22.50
Marsh-gas..	60.27
Ethyl-hydride..........................	6.80
Propyl-hydride...................................	——
Oxygen...........	.83
Nitrogen...	7.32
	100.00

A casual examination of these figures with a reference to the approximate geological horizon in each case will show several well-marked peculiarities. The Cherry Tree gas which comes from the highest geological horizon, is found to contain 22.50 per cent. of hydrogen and 60.27 per cent. of marsh-gas. This would make it the lightest of any of the gases analysed.

The four from the next lower geological horizon, *i. e.*, the Butler Co., oil-fields, show an advance upon this, and are quite similar, with two somewhat anomalous features showing, however—the 18.12 per cent. of

Digitized by Google

ethyl-hydride in the Burns Well gas and the 13.50 per cent. of hydrogen in the first sample of the Harvey Well gas. The gas from the Warren Co. geological horizon—obtained at the Sheffield Well—is very similar to the gas of the Burns Well in Butler Co.

The gas from the McKean Co. geological horizon—obtained at the Wilcox Well—is distinctly different from any of those preceding it. The 29.29 per cent. of ethyl-hydride makes it a heavier gas.

The three gases from the Lake Erie border however show the greatest differences. The per cent. of ethyl-hydride in these three analyses exceeds the per cent of marsh-gas, so that it becomes reasonable to estimate some of these heavy hydrocarbons as propyl-hydride. These three gases would be the heaviest of all those examined. An experimental determination of the specific gravity of the Erie gas made by the diffusion method gave .804. The specific gravity as calculated from the analysis was .845.

I will append several analyses of similar natural hydrocarbon gases that have come to my hand.

1. From a gas-well at West Bloomfield, N. Y. Analysed by Prof. Henry Wurtz. (Silliman's Journal (2) XLIX p. 336.)

2. From the Neff gas-well near Gambier, Knox Co. Ohio. Analysed by Prof. E. W. Morley, Hudson, Ohio. (Private communication.)

3. From a so-called "burning-spring" at St. Barthelemy, Isère, France. Analysed by F. M. Raoult. (Wagner's Jahresbericht 1870, p. 704.)

	1.	2.	3.
Carbonic acid	10.11	0.3	0.58
Carbonous oxide	——	0.5	——
Ethylene series	2.94	——	——
Hydrogen	——	——	——
Marsh-gas	82.41	81.4	98.81
Ethyl-hydride	——	12.2	——
Oxygen	0.23	0.8	0.10
Nitrogen	4.31	4.8	0.48
	100.00	100.00	99.97

In analyses No. 1 and No. 3, probably no attempt was made to distinguish between marsh-gas and Ethyl-hydride, and the figures given for marsh-gas probably express the sum of the marsh-gas hydrocarbons.

A description of the absorption tests by which I proved the presence of ethyl-hydride and propyl hydride and an explanation of the formulas by which the results of the gas-analyses were calculated appeared in my previous paper. (Vol. XVI, No. 97 of the Proceedings of the Am. Phil. Soc.; also reprinted in American Chemist for Sept. 1876).

Digitized by Google

On Eight Meteoric Fireballs seen in the United States from July, 1876, *to February*, 1877.

By Daniel Kirkwood, Professor of Mathematics in Indiana University, Bloomington, Indiana.

(*Read before the American Philosophical Society, March* 16, 1877.)

The number of meteoric fireballs observed in the United States during the latter part of 1876 and the beginning of 1877 has been quite remarkable. In several instances the meteors have exploded with tremendous detonations, and the disruption has been followed by the fall of ærolites. The description and analysis of the latter will doubtless be given to the scientific world by those who have devoted special attention to this department of research. In the meantime some account of the *meteoric* phenomena will not be without interest.

I.

The Great Meteor of July 8, 1876.

On the evening of July 8th, 1876, about fifteen minutes before nine o'clock, Chicago time, a very large meteor passed over Ohio and Michigan, and was visible in the adjacent States of Iowa, Illinois and Indiana. At Wolcottville, La Grange County, Indiana, it was well observed by Mr. William L. Taylor, a member of the senior class in Indiana University, who states that the point of first appearance was almost exactly East of Wolcottville, and at an elevation of nearly 60°. At Valparaiso, Porter County, Indiana, according to Rev. Robert Beer, it appeared a little North of East; while at Chicago it seemed to start from a point somewhat South of East and about 25° above the horizon. Mr. Benjamin Vail, of Henryville, Clarke County, Indiana, and Mr. J. W. Hollingsworth, of Paoli, Orange County, each saw the meteor under favorable circumstances. According to the former, its direction from Henryville, when first visible, was about North North-east. The observations of Messrs. Taylor and Vail thus determine the point of first visibility, while the notes of Mr. Hollingsworth, in connection with observations at Bloomington, Indiana, indicate almost precisely the same position. The body was first seen over Fulton County, Ohio, not far from latitude 41° 40′ North, longitude 84° West.

Altitude when First Visible.

Mr. Vail, who is known by the writer to be generally accurate, says the apparent altitude of the meteor when first seen at Henryville, was about 20°. The distance from that place to Ottokee, Fulton County, Ohio, is 226 miles. Mr. Vail's observation gives, therefore, about 88 miles as the vertical height of the meteor when first observed. The Paoli, Wolcottville, and Chicago observations indicate very nearly the same result.

Digitized by Google

The Point of Disappearance—Course and Length of the Visible Track.

The meteor crossed the meridian of Paoli at Berrien, Michigan ; the difference of latitude of the two positions being 235 miles. Mr. Hollingsworth says : "My observer, Mr. J. M. Andrew, describes the meteor as 'grazing' a chimney-top which was *on* his meridian 400 feet distant, and 51 feet more elevated than the observer's eye." The angle of elevation when on the meridian of Paoli was, therefore, 7° 16′. Taking into account the curvature of the earth's surface, these data give 37 miles as the altitude of the body when passing Berrien, Michigan. At Wolcottville, La Grange County, Indiana, the bearing of the point of disappearance was North 70° West, and its apparent elevation about 25°. At Chicago it was stated to be at an elevation of 50°, and somewhat North of East. These observations indicate a point over Lake Michigan, in latitude 42° North, longitude 86° 55′ West. This point is 40 miles from Chicago, 78 from Wolcottville, and 135 from Ottokee, Ohio. The altitude of the meteor at the time of its disappearance, according to the observations at Chicago and Wolcottville, was about 34 miles ; the bearing of the track, or of its projection on the earth's surface, was North 78° West ; and it was inclined to the horizon at an angle of 21°. The meteor passed vertically over the counties of Fulton and Williams, Ohio ; the North-east angle of Steuben County, Indiana ; and Branch, St. Joseph, Cass and Berrien, Michigan.

"The meteor was a very brilliant one. It lighted up the sky like the glare of a calcium light ; the intensity being several times greater than the light of the full moon."* Its mass was apparently dissolved or dissipated in the latter part of its track, leaving a luminous train which continued visible at least 40 minutes. The disappearance of the body was followed by no detonation, and if any meteoric fragments fell from the terminus of the track they must have been lost in the lake. No part of the mass, it is sufficiently obvious, could have passed out of the atmosphere.

The rare occurrence of meteors whose trains remain visible from fifteen minutes to an hour or more, seems to indicate a remarkable peculiarity in their structure and composition. Professor Ennis has suggested that they probably consist of elements easily combustible, such as potassium, sodium, calcium and magnesium.†

This meteor's motion about the sun was retrograde. The observations, however, furnished no data—or none sufficiently trustworthy—for determining either its orbital velocity or the nature of the orbit in which it moved.

II.

The Second Meteor of July 8, 1876.

Soon after the appearance of the meteor above described, the writer in a published note expressed his regret that the observations furnished by

*Chicago *Tribune*.

† Proc. of the A. A. A. S., Indianapolis Meeting.

Digitized by Google

correspondents were insufficient to determine, even approximately, the orbit of the meteor. In response to this note a communication was received from E. Lyon Linsley, of Stratford, Connecticut, who, on the same evening and nearly at the same hour, had observed a large fireball, and who supposed it to be identical with that seen in Michigan. The following is an extract from the Stratford letter:

"I saw this brilliant meteor here, on the evening of July 8th, at about nine o'clock. It was then about eight degrees from the polar star, and close to the faint northernmost visible star in the constellation *Camelopardalis*. Whether it expired then and there or disappeared behind an angle of the roof, I am unable to say; viewing it as I did from an Eastern portico, which was suddenly all aglow with its celestial light, and seeing meteor and illumination each but for a moment."

The slightest examination shows that the bolide here described was different from that seen in Michigan and the adjoining States on the same evening. We conclude accordingly that two fireballs of great brilliancy were simultaneously observed. Were they cometary fragments whose orbit intersects that of the earth near the 288th degree of longitude? It is a remarkable coincidence that on the 8th of July, 1856, somewhat earlier in the evening, a large fireball was seen in Alabama and Mississippi, which, like the meteor first described, left a luminous train that remained visible a considerable time near the terminus of its track.* It may also be mentioned as an additional coincidence that a meteoric stone-fall occurred in Spain on the 8th of July, 1811.

III.

The Fireball of December 16, 1876.

A large majority of the meteorites which reach the earth's surface must doubtless fall into the ocean, though the phenomena of their descent are very rarely witnessed. An occurrence of this kind was observed, however, according to the San Francisco daily papers, on Saturday morning, December 16, 1876, about fifteen minutes before one o'clock, when a large meteoric fireball appeared over the Pacific Ocean westward from San Francisco. When first seen it was rapidly descending towards the surface of the ocean, its apparent path making a large angle with the horizontal plane. It had been visible but a few seconds when it plunged into the Pacific at apparently no great distance from the shore. The fall was followed by a loud detonation.

IV.

The Meteor of December 21, 1876.

On Thursday evening, December 21, 1876, about seventeen minutes before nine o'clock, Bloomington time, a meteor of extraordinary magnitude passed over the States of Kansas, Missouri, Illinois, Indiana, Ohio,

See Am. Journ. Sci. for November, 1856, and January and May, 1857.

Digitized by Google

Pennsylvania and New York. I have received communications descriptive of the phenomena from Prof. F. W. Bardwell, of Lawrence, and Rev. J. L. Gay, of Parsons, Kansas; Prof. Joseph Ficklin, Columbia, Mo.; Prof. S. W. Burnham, Chicago, Ill.; Profs. D. E. Hunter, Brookston, and J. B. Roberts, Indianapolis, Ind.; Prof. Samuel J. Kirkwood, Wooster, O.; and others in the different States over which the meteor passed. At Bloomington, Ind., it was observed by Profs. T. A. Wylie, D.D., H. B. Boisen, and C. F. McNutt; also by Rev. James Garrison, Messrs. D. O. Spencer, J. Graham, and many others. A discussion of the observations furnished by the correspondents named gives the following as

The Meteor's Track through the Atmosphere.

The body when first visible was about 70 or 75 miles above the earth's surface, at a point South-west from Emporia, Kansas, and not far from the Southern border of the State. It passed Emporia a few degrees South-east of the zenith; entered Missouri near the South-west corner of Jackson county; passed very nearly over the towns of Lexington, Keytesville, and Oakdale, Missouri; Quincy, Lewiston, Peoria, and Lorain, Illinois; Winamac, Rochester, and Auburn, Indiana; Bryan and Toledo, Ohio; crossed Lake Erie to a point a few miles South of Erie, Pennsylvania, and disappeared over South-western New York. This track is not represented by a straight line drawn on the map, but by one somewhat curved towards the North or North-west. Its length is between 1000 and 1100 miles – one of the longest meteoric tracks on record. The body passed the meridian of Bloomington, Indiana, 131 miles North of the city, and its apparent elevation as determined by Prof. T. A. Wylie, D.D., was 15°. This, taking into account the curvature of the meridian, gives about 38 miles as the altitude of the meteor when over the Western part of Fulton county, Indiana. Data furnished by Prof. Samuel J. Kirkwood, of Wooster, Ohio, show the height when over Lake Erie, directly North of that city, to have been 29 miles. The estimated altitudes at other points of the track are less satisfactory.

Explosions.

Some observers in Missouri report an explosion of the meteor when passing over the central part of the State. At Bloomington, Indiana, Prof. H. B. Boisen, who saw the meteor when due West and watched it till it disappeared near the Eastern horizon, observed it separate into several parts when nearly North-west, or in the direction of Peoria, Illinois. Rev. James Garrison, who resides one mile South of Bloomington, noticed by his clock the time of the meteor's disappearance and also that of the subsequent rumbling sound together with the violent jarring of his house. The interval was 15 minutes, indicating a distance of 185 miles. The sound and jar of the explosion were heard and felt by hundreds throughout Monroe county, and by many ascribed to an earthquake. In regard to the sounds following the meteor's passage through the atmosphere, the

Digitized by Google

Monthly Weather Review for December, 1876, says: "No reliable accounts speak of any noise heard during the visibility of the meteor, but in from two to five minutes after its passage a shock resembling thunder was heard, which in the majority of cases was described as tremendous, shaking the ground and the houses, and was especially alarming to those who, on account of the prevailing cloudiness, were unable to see the preceding meteor. The uniform character of the sound heard at all the stations shows that it was not due to any violent explosion (properly so-called), but was a peculiar acoustic phenomenon, depending on the fact that that portion of the line described by the meteor when nearest to any observer, became, as it were instantaneously along a length of several miles, the origin of a series of simultaneous sounds which, although in themselves comparatively feeble, were concentrated into a violent sound when they reached the observer's ear." The view here expressed is not sustained by the observations in Monroe and the adjacent counties, as a sound from the nearest point of the meteor's track would have reached Bloomington, if at all, in 10 or 11 minutes.

When crossing Indiana the principal fireball was followed by a train or group of smaller meteors, many of which were superior in apparent magnitude to Venus or Jupiter. The breadth or apparent diameter of this cluster, as seen from Bloomington, was three degrees, and its length at least twenty degrees. Its true diameter was therefore five miles, and its length about forty miles. These smaller meteors were chiefly the results of the explosions over Central Illinois A final disruption occurred over Erie county, Pennsylvania; several minor explosions having taken place during the passage over Indiana and Ohio.

The Fulton County Fragment.

A fragment of the meteorite fell on the farm of Mr. Andrew J. Morris, three miles North-west of Rochester, Fulton county, Indiana. Mr. M., on hearing the meteoric explosion, had left his house, when he noticed a heavy body strike the earth at no great distance. Designating the spot as nearly as he could by a mark in the snow (which was six inches deep), he returned in the morning, and soon found where the meteorite had struck in the snow, rebounded and again fallen close by. The whole fragment weighed about 12 ounces. A part of it was secured by the writer and forwarded to Prof. Chas. Upham Shepard, of Amherst College, Mass. A fragment was also obtained by Mr. W. A. Roebling, of New York, and a third was sent by Prof. E. T. Cox to Dr. J. Lawrence Smith, of Louisville. No analysis, however, has yet been published. The body is peculiar in its structure; being pisolitic and remarkably friable. The fact that other portions of the mass have not been discovered may perhaps be owing to its complete disintegration.

Did the Meteor Pass Out of the Atmosphere?

The observations at Bloomington, Indiana, and Wooster, Ohio, indicate that in a flight of 200 miles eastward from Rochester the altitude dimin-

Digitized by Google

ished from 38 to 29 miles. The elevation, when over Erie County, Pennsylvania, was almost certainly less than 30 miles—probably not more than 25. After the explosion, near the South-western border of New York, the meteor became almost immediately extinct. In view of these facts it seems extremely improbable that any part of the mass could have escaped out of the atmosphere. What became of the dissevered fragments, or why none have been hitherto found near the terminus of the track, may be difficult of explanation.

Velocity.

I have not learned that the time of the meteor's visibility was by any one accurately measured. The slowness of the apparent motion was, however, very remarkable; being compared by many to that of a flock of wild geese. Several observers estimated the duration of flight at nearly two minutes. The velocity with reference to the earth's surface was probably between 8 and 12 miles per second, and with reference to the sun, between 25 and 30.

V. and VI.

The Meteors of January 3 and January 20, 1877.

The fall of ærolites, attended with the usual meteoric phenomena, occurred in Warren County, Missouri, on the 3d of January, 1877, and in Georgia, January 20th. Fragments of these bodies have been secured by Professor J. Lawrence Smith, of Louisville, Kentucky, from whom full descriptions and analyses may soon be expected.

VII.

The Meteor of January 23, 1877.

About 4 o'clock on Tuesday afternoon, January 23, 1877, a splendid meteor was seen at Gray's Mills, five miles North of Bloomington, Monroe County, Indiana, by Mr. Daniel J. Stout and several other gentlemen in company with him. Its position when first seen was nearly South-east from the place of observation, and about 35° above the horizon. Its visible track was very nearly perpendicular to the earth's surface. When near the horizon the meteor disappeared behind a hill South-east of the observers, but the disappearance was followed by no detonation. The same meteor was observed by a number of persons in Decatur County, five miles East of Greensburgh, latitude 39° 27′ North, longitude 85° 28′ West. According to the Indianapolis *Daily Journal*, of January 25th, the meteor "disappeared just as it seemed to touch the earth, apparently not more than one-fourth of a mile distant. It presented the appearance of a flexible band of beautifully polished silver, and as it pursued its downward course waved like a ribbon in the breeze. Exclamations of astonishment and admiration burst simultaneously from the lips of all who saw it." A letter in the Cincinnati *Weekly Gazette*, dated at Scott's Post Office, Kenton County,

Digitized by Google

Kentucky, January 25, states that "about 4 o'clock on the evening of the 23d, a heavy rumbling sound was heard, as if coming from a South-easterly direction, and from a point high in the heavens. The report was likened by some to the discharging of numbers of heavy ordnance, the different discharges barely distinguishable. The concussion was sufficient to rattle the glass in the windows, and also to jar the earth quite perceptibly. The course of the sound appeared to be from a point South South-east" of the writer's place of observation. The final explosion took place over Harrison County, Kentucky, and the ærolite reached the earth nine miles North of Cynthiana. It is now in the collection of Dr. J. Lawrence Smith, of Louisville.

The points from which this meteor was observed in Decatur and Monroe Counties are nearly on the same parallel; the latitude of the former being about 39° 27′, that of the latter 39° 21′. The distance between the stations is 56 miles, and the entire track, as seen from Decatur County, was East of the meridian. The observations in Monroe County indicate that the height of the meteor when first seen was at least 70 miles.

VIII.

The Meteor of February 8, 1877.

About half past 2 o'clock on Thursday morning, February 8th, 1877, a large meteor was seen by J. S. Hunter, Esq., near Ellettsville, Monroe County, Indiana. The apparent magnitude of the body seemed equal to half that of the full moon, and the sudden light was so intense as to frighten the horse of the observer. The meteor was first seen in the South-east, crossed the meridian South of the zenith, and disappeared at a point about 30° or 35° South of West, and 10° above the horizon. Numerous sparks were emitted by the body in the latter part of its track, and a luminous train remained visible several seconds. No explosion was heard.

Bloomington, Ind., *March* 7, 1877.

On the Asserted Antagonism between Nicotin and Strychnia.

By Francis L. Haynes, M. D., Assistant Surgeon to the Episcopal Hospital.

(*Read before the American Philosophical Society, March* 16, 1877.)

History.

Haughton's Experiments. The Rev. Prof. Haughton, in a communication read before the Royal Irish Academy, in Nov. 1856, was the first to call attention to the subject under consideration. He related the details of the following experiments on frogs: 1. A frog was placed in a bath composed of five ounces of water and five grains of nicotin. It died in twenty-three minutes. 2. A frog was placed in a bath of twenty ounces of water

Digitized by Google

and five grains of nicotin. It died in forty-three minutes, with peculiar convulsions. 3. A frog, placed in a solution of strychnia (five grains to five ounces of water), was immediately seized with tetanic convulsions, and died in four minutes. 4. A frog, placed in a solution of strychnia (five grains to twenty ounces of water), became speedily convulsed, and died in fifty-five minutes. 5. A frog, placed in a bath containing nicotin and strychnia (of each five grains to ten ounces of water), remained there nineteen minutes without any inconvenience, when it was seized with tetanic convulsions, which continued, but with less violence than in the previous experiments. After forty-seven minutes, the animal was removed, and washed in cold water. It lived afterwards more than twenty-four hours, exhibiting at intervals tetanic convulsions. 6. A frog was placed in a bath of nicotin and strychnia, as in the last experiment, and removed after ten minutes. In forty-two minutes, tetanic convulsions appeared, and continued for many hours, but they were succeeded by perfect recovery.

Wormley's Experiments. To each of thirteen cats, one-half grain of strychnia was given. "The poison was passed in solution into the stomach, by means of the stomach-tube. In some instances, as soon as symptoms of poisoning appeared, an infusion of twenty grains of tobacco leaves was administered, in the same manner as the poison; while, in others, the tobacco infusion was given along with the strychnia, the two infusions being thoroughly mixed. In some few cases, the dose of tobacco was repeated. As the result of these experiments, one of the animals, which had taken the mixed solutions, immediately fell prostrate, breathed with difficulty, in three minutes voided urine, in eight minutes vomited a frothy mucus, and in ten minutes was able to run, with, however, a stiff gait. After an hour, the animal appeared perfectly well, with the exception of a slight stiffness in walking. With this single exception, all the animals died, and, in most instances, within the usual period. One of them, however, that had taken the mixed solutions, manifested no symptom whatever, for thirty-five minutes. In some instances, the strychnine symptoms appeared to be not in the least affected by the tobacco. But, in others, they were of a compound nature. Several of the animals vomited. Before performing these experiments, it was ascertained that an infusion of twenty grains of tobacco, given alone, would produce serious symptoms; but, in no instance, in six experiments, did it cause death."—(*Micro-Chemistry of Poisons*, New York, 1865, p. 545.)

Reese's Experiments were made on dogs. The drugs were, as a rule, given by the mouth. 1. Three-fourths of a grain of strychnia, hypodermically, killed a moderate sized dog, in nine and one-half minutes. 2. Three-fourths of a grain of strychnia, and two drachms of a concentrated infusion of tobacco, were given by the mouth. Twenty-six minutes, tetanic spasms; thirty-one minutes, non-tetanic spasm; thirty-three minutes, somewhat tetanic spasm; thirty-nine minutes, one-half drachm of infusion of tobacco was given hypodermically, and was immediately followed by a tetanic spasm, and death. 3. Two drachms of tobacco infusion. Five minutes, free

Digitized by Google

vomiting; twenty minutes, quite well. Thirty minutes, three-fourths grain strychnia and two drachms tobacco infusion given; trembling, panting respiration. Forty-three minutes, tetanic spasm; forty-five minutes, death. 4. Two drachms tobacco infusion; uneasiness, panting, vomiting, recovery. Twenty-five minutes, the dose was repeated; vomiting, trembling, panting. Fifty-one minutes, two drachms tobacco infusion with one-half grain strychnia; weakness, panting and trembling. Eighty-nine minutes, the combined dose of tobacco and strychnia repeated; noisy and panting respiration, increased reflex excitability, spasms sometimes tetanic and sometimes not. One hundred and nine minutes, died, without convulsion. 5. Half a drachm of tobacco infusion, hypodermically, repeated in five minutes; six minutes, retching and vomiting; fourteen minutes, strychnia, one third grain hypodermically; seventeen minutes, tetanic spasm; nineteen minutes, death.—(*Am. Jour. Med. Sci.*, April, 1871, p. 382.)

Cases of Strychnia Poisoning Treated by Tobacco.

O'Reilly's Case. A sailor took six grains of strychnia in beer. Soon after, he took an emetic, and vomited freely, but, notwithstanding, violent symptoms set in. One and a quarter hour after he had taken the strychnia, he was given an infusion of tobacco, and this was continued at intervals. After about twelve hours, all the symptoms had disappeared. It is not stated how the tobacco acted, but, merely, that in two hours after he had commenced taking tobacco, "favorable symptoms set in." In all, an infusion of one and a quarter ounce of tobacco was used. (*British and Foreign Medico-Chirurg. Rev.* Oct., 1859, p. 532.)

Smyly's Case. A boy, aged 15, swallowed as much strychnia as would cover a shilling, and ate a quantity of raisins to take away the taste. In forty minutes, he fell into his master's arms, tetanic. Tarter emetic was given, but it did not act. He was put under chloroform, and removed to a hospital. Emetics were given, but did not act. Next an infusion of three ounces of tobacco, in three pints of tepid water, was given, in three doses. Each dose was followed by furious vomiting. Profuse sweating occurred; the patient slept, and had no further trouble. (*Dublin Quart. Jour.* 1862, p. 183.)

Chever's Case. A Mohammedan girl, aged 11, took about three grains of strychnia, chewed it, spat out, as she thought, the whole of it, and then swallowed some water to remove the taste. In about forty minutes, a convulsion occurred. An emetic was given by the husband. She was taken to a hospital, three hours after taking the strychnia, and, up to that time, had had five convulsions. An emetic was given, and followed by large quantities of animal charcoal and lard, and small doses of infusion of tobacco. Two hours after admission, a severe convulsion occurred, lasting six minutes. Three hours after admission, there was free vomiting. Recovery ensued. She received in all, *two and one-third grains* of tobacco in infusion. It is stated that none of the emetics given acted satisfactorily, until the tobacco was given. (*British and Foreign Medico-Chirurg. Rev.* 1876, p. 242.)

Digitized by Google

Writer's Experiments.

The following experiments were made on rats, cats, rabbits, and dogs. The poisons were invariably injected under the skin.

The time given refers to the period of the injection of the poison ; or, if more injections than one were made, the time is dated from the first injection.

In all cases in which an animal was killed by strychnia, or nicotin, or by both combined, the heart continued to beat for a variable time after respiration had ceased.

A. *On Rats.*

The ordinary stable rats were used. First, the minimum fatal dose and the physiological action of nicotin were determined, and, next, the action of nicotin and strychnia combined.

I. *Minimum Fatal Dose of Strychnia Sulphate on Rats.*

This was found by J. Hughes Bennett (*Antagonism of Medicines*, London, 1875, p. 14) to be about 1-60 of a grain of the pure alkaloid. The rats used by Bennett averaged about one ounce more in weight than those employed by the present writer. Of course the dose of the sulphate is proportionally larger.

II. *Minimum Fatal Dose and Physiological Action of Nicotin on Rats.*

When a small dose of nicotin (♏1-1000 to ♏1-600) is injected into a rat, its respiration becomes labored, and, sometimes, noisy ; and the animal shows signs of prostration, but is able to make voluntary motions. After larger doses (♏1-600 to ♏1-140), convulsions occur, which may be either clonic or tetanic. The convulsions may be preceded, and are always succeeded, by more or less complete paralysis of motion. One convulsion may terminate life, but, generally, the animal survives through several convulsions. The respiration, after each convulsion, ceases for several seconds, and, sometimes, for more than a minute. When death occurs, it is through failure of the respiration. The heart invariably continues to beat for a time after respiration has ceased. Purging and urination are frequent symptoms.

From the following experiments, the minimum fatal dose of nicotin, for rats, was found to be about 1-150 of a minim (taking the average weight to be about 10¼ ounces).

Digitized by Google

Table I.

Showing the Effects of Nicotin on Rats, and indicating the Minimum Lethal Dose.

No.	*Weight of Rat.*	*Dose of Nicotin in parts of a Minim.*	*Result.*	Symptoms.
1	10¼ oz.	1-1000	Recovery	Ran around the room actively for 5 minutes, then less actively till 10th *min.*; after which lay quiet unless disturbed, when it ran, but with difficulty. Respiration, after 5th *min.*, difficult—the walls of the chest exhibited a greater extent of motion than usual. Could be handled, without biting. 37 *min.*, recovering.
2	10¾ oz.	1-800	Recovery.	Immediately lay quiet and breathed laboriously, and after the 6th *min.* noisily. At intervals, slight convulsive movements. At no time was there inability to move when disturbed. 13 *min.*, recovering.
3	6¼ oz.	1-700	Recovery.	After ½ *min.*, lay quietly, breathing laboriously. 4 *min.*, can barely move when disturbed. Respiration noisy, and slower than normal. 8½ *min.*, respiration gasping, 58 a minute. 22 *min.*, respiration still labored, 80; moves more readily.
4	10¼ oz.	1-666	Recovery.	Panting respiration, and semi-paralysis. Recovery after 30 *min.*
5	10¼ oz.	1-600	Recovery.	Same as in last experiment.
6	8 oz.	1-600	Death.	After 15 *sec.*, hissing and laborious respiration: moved rapidly around the cage till 40 *sec.*; then lay, gasping for breath, till 60 *sec.*, when tetanoid convulsions occurred, which caused respiration to cease at the end of the 2d *min.*
7	11 oz.	1-550	Recovery.	½ *min.*, difficult respiration. 1 *min.*, paralysis. 2½ *min.*, clonic convulsions with opisthotonos, which continued at intervals till 8*th min.*, when they ceased, and the respiration became gasping and infrequent, 10 per minute; and there was complete motor paralysis. 12 *min.*, respiration re-established, hissing. 35 *min.*, slight voluntary movements. 60 *min.*, almost constant convulsive trembling, with laborious and occasionally noisy respiration. 2 *hrs.* condition the same. Very slight movements occasionally.
8	6¼ oz.	1-500	Recovery.	Same as in last experiment.
9	8¾ oz.	1-440	Recovery.	Immediately difficult respiration. ¼ *min.*, violent tetanic convulsions, succeeded by panting noisy respiration, and complete motor paralysis. Very rapid muscular quiverings, causing such rapid movements of one foreleg that they could scarcely be seen. 19 *min.*, recovering voluntary power.
10	10¼ oz.	1-400	Recovery.	Usual symptoms. Convulsions clonic and tonic.
11	10 oz.	1-300	Recovery.	Usual symptoms. Convulsions clonic.
12	10 oz.	1-230	Recovery.	Difficult respiration, slight clonic convulsions, and semi-paralysis.
13	11¼ oz.	1-230	Recovery.	Difficult respiration, no convulsions, semi-paralysis.
14	10¼ oz.	1-230	Recovery.	Same as in last experiment.
15	8 oz.	1-230	Recovery.	Difficult respiration. 3½ *min.*, violent tetanic convulsions, after which respiration ceased for 15 sec., then recommenced with a gasp. There was semi-paralysis for a few minutes, but by 18 *min.* the animal had almost recovered.
16	4½ oz.	1-200	Death.	Immediately clonic convulsions, which ended fatally in ½ *min.*
17	10¼ oz.	1-194	Death.	Ran around the room for ½ *min.*, when he stopped, and the respiration was noted noisy and laborious. 2 *min.*, complete motor paralysis. 3½ *min.*, violent clonic convulsions lasting till 4½ *min.* Respiration now ceased till 5½ *min.*, recommenced with a gasp, and ceased finally at 6 *min.*

Digitized by Google

TABLE I.—CONTINUED.

No.	*Weight of Rat.*	*Dose of Nicotin in parts of a Minim.*	*Result.*	SYMPTOMS.
18	7¾ oz.	1-176	Death.	1½ *min.*, convulsions, succeeded by difficult respiration and semi-paralysis. 25 *min.*, complete paralysis. 2¼ *hrs.*, moves limbs slightly when disturbed. Death at 3 *hrs.*, the respiration falling gradually down to 6, then to 1, per minute.
19	10⅛ oz.	1-176	Recovery.	1 *min.*, labored respiration. 4 *min.*, prolonged tetanic convulsion, followed by the usual respiratory difficulty and semi-paralysis. 60 *min.* recovery.
20	9¼ oz.	1-143	Death.	½ *min.*, noisy, labored respiration; convulsions, lasting 3 min., then almost complete paralysis. 53 *min.*, convulsions excited by slight irritation, semi-paralysis till 144 min., when slight voluntary motions were noted. 20 *hrs.*, respiration feeble, 30; lay powerless on the side, and had tetanic and clonic convulsions when disturbed. 20½ *hrs.*, heart beats, 93; respiration, 15. Entire paralysis. 23 *hrs.*, death from failure of respiration, which had occurred once a minute for some time previously.
21	7¾ oz.	1-143	Death.	Same as in last experiment. Death after 5 *hrs.*

III. *Effects of Nicotin and Strychnia Sulphate, when Injected Simultaneously.*

First, the drugs were injected in less than fatal doses; next, fatal doses were employed.

TABLE II.

Strychnia Sulphate and Nicotin, injected simultaneously, in Non-fatal Doses.

No.	*Weight of Rat.*	*Dose of Strychn. Sulph. in parts of a grain.*	*Dose of Nicotin in parts of a Minim.*	RESULTS.	*Result of Crucial Experiment performed Nine Days afterwards.*
22	9¾ oz.	1-96	1-1000	Ran around the room actively for 4 *min.*, then kept quiet, unless disturbed, for ½ *hr.* During this time, the respiration was panting.	Strychnia Sulphate gr. 1-96, alone, produced no effect. For the effect of ♏ 1-1000 Nicotin see Experiment 1.
23	8⅛ oz.	1-96	1-800	After 1 *min.*, difficult respiration and prostration. 8 *min.*, almost complete paralysis, convulsive motions occasionally. Increased reflex excitability. 27 *min.*, recovering.	Strychnia Sulphate, gr. 1-96, alone, produced a slight increase of reflex excitability. For effects of Nicotin, ♏ 1-800, see Experiments 1, 2, and 3.
24	10¼ oz.	1-64	1-800	Difficult respiration, increased reflex excitability, and indisposition to move.	Strychnia Sulphate, gr. 1-64, produced slight increase of reflex excitability.
25	10¼ oz.	1-96	1-666	Very difficult respiration, and semi-paralysis. The animal had scarcely begun to recover at the end of 45 *min.*	Nicotin, ♏ 1-666, produced difficulty of respiration and semi-paralysis lasting 30 *min.*

Digitized by Google

TABLE II.—CONTINUED.

No.	Weight of Rat.	Dose of Strychn. Sulph. in parts of a grain.	Dose of Nicotin in parts of a Minim.	RESULTS.	Result of Crucial Experiment performed Nine Days afterwards.
26	11 oz.	1-96	1-400	Immediately, difficult respiration and almost complete paralysis; then convulsive trembling. At 11 *min.*, violent convulsions, after which there was semi-paralysis, with very difficult respiration.	Nicotin, ℳ 1-400, produced difficult respiration, semi-paralysis, and convulsions.
27	8 oz.	1-96	1-230	½ *min.*, panting respiration, and almost complete paralysis. 2¼ *min.*, convulsions, which recurred every few seconds till the 5th *min.* They were sometimes clonic, and sometimes tonic. The animal lay quiet till the 11th *min.*, when there was another convulsion. 13 *min.*, convulsion, marked reflex excitability. 65 *min.*, slight convulsion.	Nicotin, ℳ 1-230, was followed by difficult respiration and powerful tetanic convulsions. At 18 *min.*, entire recovery.
28	11¼ oz.	1-96	1-230	1 *min.*, panting respiration, semi-paralysis. 1½ *min.*, violent convulsions, after which respiration temporarily ceased, then recommenced with a gasp. Prolonged exhaustion.	Nicotin, ℳ 1-230, caused difficult respiration and semi-paralysis, but no convulsions.
29	10¼ oz.	1-96	1-230	Same as in Experiment 23.	Nicotin, ℳ 1-230, produced same effects as in Experiment 28.
30	10¼ oz.	1-96	1-176	1 *min.*, irregular convulsions, followed by difficult respiration and prostration. 35 *min.*, severe irregular convulsions, followed by marked increase of reflex excitability. 75 *min.*, marked tetanic convulsion. 2¼ *hrs.*, there have been occasional convulsive movements, but at no time paralysis.	Nicotin, ℳ 1-176, had been given alone 1 week previously. It had caused severe convulsions, but the animal had recovered in 1 *hr.*

The effects of fatal doses of Strychnia Sulphate, injected with, or followed by, varying doses of Nicotin ; and of fatal doses of Nicotin, injected with, or followed by, varying doses of Strychnia Sulphate, were next noted. The results are given in the following table. It will be noticed, that in some cases either drug was given in divided doses, and that, in these cases, the total amounts given are mentioned in the appropriate column.

Digitized by Google

Table III.

Experiments in which Nicotin and Strychnia Sulphate were given together, or at short intervals, Fatal or nearly Fatal Doses of either Drug being employed.

No.	Weight of Rat.	Dose of Strychn. Sulph. in parts of a grain.	Dose of Nicotin in parts of a Minim.	Result.	Symptoms, &c.
31	8 oz.	1-48	1-2000	Death.	After 1 *min.* the animal stood quiet, breathing with great difficulty. Occasional convulsive jerks were noted, and at 20 *min.* a tetanic convulsion (with emprosthotonos) and death.
32	8⅛ oz.	1-48	1-1000	Death.	The animal stood quietly, breathing somewhat heavily, until 30 *min.*, when there was a tetanic spasm, and death.
33	5 oz.	1-44	1-1000	Death.	After 3 *min.*, difficult respiration, and marked reflex excitability. 5 *min.*, slight convulsion, after which the respiration was slow and difficult, and the animal walked with great difficulty, and only when irritated. 15 and 27 *min.*, slight convulsions. 42 *min.*, tetanic convulsion, and death.
34	9½ oz.	1-48	1-800	Death.	1 *min.*, panting respiration. 5 *min.*, increased reflex excitability; prostration. 25 *min.*, tetanic convulsion, and death.
35	9½ oz.	1-31	1-800	Death.	The animal immediately lay on side paralyzed, and continued so till death, which followed an irregular convulsion at 2 *min.* The respiration was slow and gasping throughout.
36	6⅞ oz.	1-48	1-500	Death.	The nicotin was given in divided doses. ♏ 1-1000 was given with the Strychnia Sulphate. The rat stood quietly, breathing heavily until 12 *min.*, when there was convulsive trembling. An attempt to use the hypodermic syringe caused a convulsion. Nicotin, ♏ 1-2000, was now injected. At 20 *min.*, a second tetanic convulsion occurred, and immediately after Nicotin, ♏ 1-2000 was injected. At 22 *min.*, tetanic convulsion, and death.
37	5⅝ oz.	1-48	1-500	Death.	Immediately, almost complete paralysis, and panting respiration. From 1½ to 4 *min.*, continuous opisthotonos, with exceedingly rapid vibrations of the extremities. The respiration became slower and slower; at times, intervals of 10 sec. passed between the respiratory acts. 4 *min.*, slight convulsive motions. 7 *min.*, slight voluntary motions. Increased reflex excitability. Convulsions at 22, 34, and 37 *min.*, then death.
38	9¼ oz.	1-48	1-500	Death.	Nicotin given in divided doses, as detailed below. 5 *min.* after injection of Strychnia Sulphate, no effect was apparent, except increased reflex excitability. Nicotin, ♏ 1-1000, was injected. 10 *min.*, the rat is inactive; respiration somewhat labored. Increased reflex excitability. Nicotin, ♏ 1-1000, was injected. The respiration immediately became more difficult; the animal staggered, fell on side, and, at 13½ *min.*, had a violent tetanic spasm (emprosthotonos), terminating in death.
39	6⅞ oz.	1-48	1-800	Death.	The animal stood quietly, breathing heavily. 5 *min.*, almost helpless; marked reflex excitability. 13½ *min.*, tetanic spasm, and death.
40	9¾ oz.	1-48	1-400	Death.	Difficult respiration, increased reflex excitability, and almost complete paralysis, till 22 *min.*, when there was a single tetanic spasm, and death.
41	10¼ oz.	1-48	1-600	Death.	½ *min.*, difficult respiration; stands motionless, or moves with difficulty, if disturbed. 15 to 18 *min.*, slight convulsions. 25 *min.*, tetanic convulsion, and death.

Digitized by Google

TABLE III.—CONTINUED.

No.	Weight of Rat.	Dose of Strychn. Sulph. in parts of a grain.	Dose of Nicotin in parts of a Minim.	Result.	SYMPTOMS, &c.
42	10 oz.	1-96	1-220	Death.	The Nicotin was first injected; immediately after, difficult respiration, and semi-paralysis. 6 *min.*, irregular convulsions which terminated in cessation of respiration for 15 sec., when it re-commenced with a gasp. There was now complete paralysis (excepting of course the heart and respiration). At 25 *min.*, the animal was beginning to recover power, when Strychnia Sulphate, gr. 1-96, was injected. 43 *min.*, increased reflex excitability. 50 *min.*, tetanic convulsion, and death. *Post mortem*—The heart was exposed; it continued to beat for 10 min.
43	7⅛ oz.	1-96	1-200	Death	Immediately, violent convulsions, lasting one min., followed by temporary cessation of respiration, which recommenced with a gasp. Almost complete paralysis till 23 *min.*, when the convulsions recurred, and terminated in death.
44	6 oz.	1-192	1-200	Death.	The Nicotin was first injected; it was followed in ½ *min.* by a tetanic convulsion, lasting 2 *min.*; then semi-paralysis. 4 *min.*, Strychnia Sulphate, gr. 1-192, was injected. 10 *min.*, the semi-paralyzed condition continued. Reflex excitability increased. 14 *min.*, tetanic, alternating with clonic, convulsions commenced, and lasted for 8 min., after which there was almost complete paralysis 33 *min.*, tetanic convulsion, and death.
45	8½ oz.	1-96	1-130	Death.	Convulsions for 5 *min.*, succeeded by semi-paralysis, and increased, reflex excitability, with extreme difficulty in respiration. 2 *hrs.*, slight voluntary motions. 20 *hrs.*, almost complete paralysis; no convulsions. 21 *hrs.*, complete paralysis; slight convulsive movements occasionally. 23 *hrs.*, death from failure of respiration, which had become very infrequent (one a minute).
46	9½ oz.	1-96	1-125	Death.	1 *min.*, tetanic convulsion, lasting 2 *min.*, and followed by semi-paralysis and difficult respiration. 28 *min.*, tetanic convulsion, and death.

B. *On Cats.*

As in the preceding series of experiments, the minimum fatal dose and the physiological effects of the two poisons were first ascertained.

I. *Minimum Fatal Dose of Strychnia Sulphate on Cats.*

This was found to be about 1-425 of a grain to the pound. It is probable, however, that age and individual peculiarities produce variations in the effects of this and other poisons.

Digitized by Google

TABLE IV.

Indicating the Minimum Fatal Dose and Physiological Effects of Strychnia Sulphate on Cats.

No.	Weight.	Dose of Strychnia Sulphate in parts of a grain.	Result.	SYMPTOMS.
47	7¼ lb.	1-16	Death.	A single convulsion caused death in 5 *min.*
48	1¼ lb.	1-30	Death.	A single convulsion caused death in 5 *min.*
49	3¼ lb.	1-30	Death.	In 13 *min.*
50	5¾ lb.	1-60	Death.	In 75 *min.*
51	5 lb. 15½ oz.	1-96	Recovery.	After 22 *min.*, panting, labored respiration. Great reflex excitability; slight convulsions, when disturbed; when not disturbed, sat motionless. After 1 *hour*, recovered.
52	3 lb.	1-144	Recovery.	In 15 *min.* extremely violent convulsions, lasting 2 *min.* Then the animal lay motionless on its side for 10 *min.*, and then was able to move, but with great difficulty. Convulsions occured at 47, 67, and 85 *min.*
53	2 lb. 14 oz.	1-192	Death.	After 15 *min.* a single tetanic convulsion, and death.
54	2 lb. 1 oz.	1-210	Recovery.	Marked reflex excitability and difficult locomotion.
55	2 lb. 1 oz.	1-240	Recovery.	No effect.
56	1 lb. 13 oz.	1-280	Recovery.	Marked reflex excitability; locomotion almost impossible for 1 hour.
57	1¼ lb.	1-280	Death.	In 19 *min.*
58	1 lb. 14 oz.	1-280	Recovery.	Barely escaped with life, after several severe convulsions.
59	1½ lb.	1-300	Death.	In 25 *min.*
60	1½ lb.	1-330	Recovery.	Barely escaped with life, after severe convulsions.
61	1 lb. 11 oz.	1-373	Recovery.	Slight rigidity of extremities, lasting 1 hour.
62	1 lb. 14 oz.	1-560	Recovery.	Slight rigidity of extremities.
63	½ lb.	1-400	Death.	After several hours.
64	2 lb. 3½ oz.	1-200	Death.	After two convulsions, in 50 *min.*

II. *Minimum Fatal Dose and Physiological Action of Nicotin on Cats.*

The least fatal dose was found to be about 1-150 of a minim to the pound. The physiological effects do not materially differ from those observed in rats. An additional symptom is extremely violent vomiting, due to gastro-intestinal spasm. (*Nasse.*)

Digitized by Google

Table V.

Showing the Effects of Nicotin on Cats, and the Minimum Lethal Dose.

No.	*Weight of Cat.*	*Dose of Nicotin in parts of a Minim.*	*Result.*	Symptoms.
65	5 lb. 15 oz.	1-30	Recovery.	Respiration slow and labored for ½ *min.*, then rapid and panting. Twitching of the ears. Disinclination to move. 45 *min.*, recovering.
66	8 lb.	1-20	Recovery.	The animal moved rapidly around the room for 9 *min.* Then vomiting occurred, and was followed by violent retching. He uttered incessant cries, and walked around, but less actively. The respiration was slow and panting; the pupils contracted. 20 *min.*, he walks with difficulty, having imperfect control over the posterior extremities. 1 *hour*, recovering.
67	8 lb.	1-19	Recovery.	Before the injection, the pulse was 150, and the respiration 51, a minute; the pupils were 9-20 in. in diameter. 2 *min.*, walks with great difficulty. Cries out anxiously. Purging and salivation. Respiration 45, noisy and difficult. Pupils 8-20. 8 *min.*, lay stretched out on side. Respiration 150. Pupils 7-20; nictitating membrane drawn over eye. 12 *min.*, walks with great difficulty, when disturbed. Respiration extremely rapid and panting. 27 *min.*, moves head, when tail is pinched, but cannot move rest of body. 37 *min.*, convulsive twitching of ears. 45 *min.*, paralysis and complete unconsciousness. · Respiration 84. Pupils 10-20. 123 *min.*, recovering.
68	8 lb.	1-18	Death.	Before the experiment, respiration 36; pulse 156; pupils 10-20. 1 *min.*, respiration 30, very labored. 2½ *min.*, respiration 66, whistling; cried out; ears twitched; salivation. 4 *min.*, respiration 144; pupils 4-20; violent retching, purging. The animal lay apparently powerless, but moved, though with great difficulty, when disturbed; the extremities were quite rigid. No convulsive movements were apparent, except in the ears, but all the muscles (especially the masseters) could be felt rapidly vibrating. 12 *min.*, entire paralysis; legs jerked. 13 *min.*, respiration 63, noiseless; slight clonic convulsion. The respiration now became more and more infrequent, and finally ceased at 15 *min.* The heart beat five minutes longer. The pupil just before death was 8-20.
69	5 lb. 6 oz.	1-30	Death.	Before the experiment, the respiration was 57, the pupil 9-20. 1 *min.*, respiration 120, panting. 2 *min.*, lay on side; ears twitched; violent retching. 7 *min.*, respiration 45, not noisy, but very laborious; pupils 8-20. 11 *min.*, walked a few paces, with great difficulty. 12 *min.*, irregular convulsions, lasting ½ minute, and ending in death, through failure of respiration. The heart continued to beat for a few minutes.
70	3 lb.	1-60	Death.	Difficult respiration; vomiting, purging, and urination; tetanic convulsions, and death at 7 *min.*
71	3 lb. 9 oz.	1-35	Death.	Immediately on termination of injection, tetanic convulsions set in, and lasted for 1 minute, when the respiration ceased.

Digitized by Google

III. *Effects of the Combined Action of Nicotin and Strychnia Sulphate on Cats.*

Experiment 72.

Strychnia Sulph. gr. 1-292 and Nicotin ♏1-40 were injected together into a cat, weighing 1 lb. 14½ oz. The animal immediately breathed noisily and with difficulty; the ears twitched rapidly. He walked around the room with great difficulty, and at 4 *minutes* fell over on the side convulsed, and shortly expired. The heart continued to beat for a time after respiration had ceased, and this was the case in all the subsequent experiments.

Experiment 73.

Strychnia Sulph. gr. 1-192 and Nicotin ♏1-20 were injected together into a cat, weighing 2 lbs. 5 oz. The symptoms were: rapid, noisy, labored respiration; violent retching, and purging; in 2 *minutes*, tetanic convulsion, and in 4 *min.* death. Convulsive movements of the muscles of the head continued for several minutes after death.

Experiment 74.

Strychnia Sulph. gr. 1-288 and Nicotin ♏1-70 were injected together into a cat, weighing 2 lbs. ½ oz. The symptoms were the same as in the preceding experiment. Death occurred at 5½ minutes.

Experiment 75.

Strychnia Sulph. gr. 1-130 and Nicotin ♏1-75 were injected together into a cat, weighing 3 lbs. 9 oz. ½ *min.*, the cat walked around the room, staggering; extremities stiff; respiration slow and panting. 3 *min.*, he lay motionless on the side, but was able to move slightly, if irritated. There was marked reflex excitability. The respiration was rapid and difficult. 6 *min.*, slight, momentary, clonic convulsion. The respiration now became more and more feeble and infrequent, and ceased at 12 *minutes.*

Experiment 76.

Strychnia Sulph. gr. 1-74 and Nicotin ♏1-40 were injected together into a cat, weighing 6½ lbs. 3 *min.*, he ran around, crying anxiously. The respiration was slow, panting, and labored. 4 *min.*, he lay over on the side occasionally, as if exhausted. Convulsive twitching of the ears, and violent vomiting and retching, now commenced. The membrana nictitans was drawn. 5½ *min.*, he lay stretched out, motionless, on the side, but could walk, though with great difficulty, when disturbed. 9 *min.*, clonic, succeeded by tetanic, convulsions set in, and caused death.

Experiment 77.

Strychnia Sulph. gr. 1-74 and Nicotin ♏1-30 were injected together into a cat, weighing 6 lbs. 6 oz. The usual difficulty of breathing, vomiting, and prostration, ensued. The pupil was contracted. At 6½ *min.*, feeble convulsions occurred, lasted ½ minute, and were succeeded by complete paralysis. Respiration ceased at 9 *minutes.*

Digitized by Google

Experiment 78.

Strychnia Sulph. gr. 1-96 and Nicotin ♏1-63 were injected together into a cat, weighing 5 lbs. 3 oz. After 5 *min.*, twitching of ears; panting, rapid, labored respiration; contracted pupils. These symptoms, together with violent vomiting, continued till 15 minutes: when, in addition, marked reflex excitability was noted. 17 *min.*, convulsive jerking, which continued at intervals until 37 *min.*, when a violent tetanic convulsion occurred, and killed the animal. The symptoms, up to 15 *min.*, were those peculiar to Nicotin; then the convulsive action of Strychnia showed itself, increased, probably, by the identical action of Nicotin. At no time was there paralysis; the dose of Nicotin was not large enough to produce this symptom.

Experiments 79, 80, 81.

(79) A cat weighing 2 lbs. 3 oz. received Strychnia Sulph. gr. 1-288. No symptoms resulted.

(80) The same animal, one week afterwards, received Nicotin ♏1-86. The symptoms lasted about one hour, and were as follows: violent vomiting, staggering gait, contracted pupils, twitching of the ears, and rapid, noisy respiration.

(81) The same animal, one week afterwards, received, by a single injection, Strychnia Sulph. gr. 1-288 and Nicotin ♏1-86. The respiration immediately became rapid and labored. In 30 *seconds* clonic convulsions commenced, and lasted till death, which occurred at 2 *minutes*.

Experiments 82, 83.

(82) A kitten, weighing 1 lb. 12 oz., received Strychnia Sulph. gr. 1-384. 27 *min.*, a tetanic spasm occurred, and lasted one minute. The animal then lay perfectly motionless, with panting respiration, for 5 minutes; and afterwards rapidly recovered.

(83) The same kitten, one week afterwards, weighing 1 lb. 14½ oz., received Strychnia Sulph. gr. 1-384, together with Nicotin ♏1-100. After 1 *min.*, the animal breathed laboriously, and walked with difficulty. 2 *min.*, twitching of ears, violent vomiting. 3 *min.*, respiration very labored and noisy. Limbs very stiff. Vomiting continues. 15 *min.*, convulsions, somewhat tetanic; death at 17 *min.*

Experiments 84, 85.

(84) A cat, weighing 6 lbs. 5 oz., received Strychnia Sulph. gr. 1-96. No result ensued, except slight increase of reflex excitability.

(85) The same animal, 20 days afterwards, weighing the same, received the same dose of Strychnia Sulph., together with Nicotin ♏1-50. The respiration immediately became difficult, then panting. 8 *min.*, twitching of ears. 9 *min.*, retching. 10 *min.*, the animal became convulsed, and in this condition leaped high in the air, then ran around the room, and at 11 *minutes* dropped dead.

Experiments 86, 87, 88.

(86) A cat, weighing 6½ lbs., received Strychnia Sulph. gr. 1-82. No symptoms ensued, except temporary stiffness in walking.

Digitized by Google

(87) The same animal, one week afterward, received Nicotin ♏1-30. The symptoms were: very difficult respiration; twitching of the ears; vomiting and purging; marked prostration. After 1½ hrs., the animal began to recover.

(88) The same animal, one week after the last experiment, received together Strychnia Sulph. gr. 1-82 and Nicotin ♏ 1-30. After 1 *min.*, difficult respiration, and twitching of the ears. 3 *min.*, violent vomiting, purging, and urination. The animal lay over on the side, breathing very noisily. 12 *min.*, tetanic convulsion, and death.

C. *On Rabbits.*

I. *Minimum Lethal Dose of Strychnia Sulph. on Rabbits.*

This has been determined by Bennett, as regards the pure alkaloid, to be 1-288 of a grain to the pound. Of course, the dose of the sulphate must be proportionally greater.

II. *Minimum Lethal Dose and Physiological effect of Nicotin on Rabbits.*

The minimum fatal dose was found to be about 1-80 of a minim to the pound, or 1-27 of a minim to a rabbit of average size (3 lbs.). The essential symptoms caused by Nicotin, as in the cases of cats and rats, are paralysis and convulsions, with profound disturbance of respiration. Vomiting does not occur; purging and urination are not as common symptoms as they are in the cat. Rabbits are generally killed by a single convulsion, whether caused by Nicotin or Strychnia.

Table VI.

Showing the Effects of Various Doses of Nicotin on Rabbits, and Indicating the Least Fatal Dose.

No.	*Weight.*	*Dose of Nicotin in parts of a Minim.*	*Result.*	Symptoms.
89	3 ℔. 4¼ oz.	1-60	Recovery.	After 10 *min.*, the animal was somewhat languid, and rested at full length. 1 *hour*, perfect recovery.
90	3 ℔. 13 oz.	1-54	Recovery.	Temporary weakness. Contraction of the pupil.
91	3 ℔. 2 oz.	1-30	Recovery.	After 10 *min*, languid. After 20 *min.*, dragged hinder legs somewhat when walking. After 30 *min.*, ceased to drag hinder legs, but walked as if they were somewhat stiff. Pupil contracted.
92	3 ℔. 4¼ oz.	1-18	Recovery.	Temporary prostration, contraction of pupil.
93	3 ℔. 1 oz.	1-15	Recovery.	After 3 *min.*, languid. The posterior extremities were dragged somewhat in walking, then were moved altogether, as if they were stiff. Pupils contracted. 15 *min.*, the animal moved around in a small circle. There were jerking movements of the body, which lasted a few seconds, and were succeeded by extreme prostration, without actual paralysis. After 45 *min.*, recovering.

Digitized by Google

TABLE VI.—CONTINUED.

No.	Weight.	Dose of Nicotin in parts of a Minim.	Result.	SYMPTOMS.
94	3 lb. 2 oz.	1-42	Recovery.	Temporary prostration and contraction of pupil.
95	3 lb. 4¼ oz.	1-30	Recovery.	After 7 *min.*, paralysis of hinder extremities, and shortly afterwards of anterior extremities. The paralysis continued until 30 *min.*, when if disturbed the animal could move a short distance, on her belly, all the limbs extended sideways. Rapid recovery ensued.
96	3 lb. 1 oz.	1-28	Recovery.	4 *min.*, she ran around the room, convulsed, screaming loudly and sharply. 4½ *min.*, rested quietly; panting respiration. 6 *min.*, ran around the room for ½ minute, convulsed, and screaming. After this, she became paralyzed, and lay stretched out on the belly. Respiration rapid and labored. This condition continued till 43 *min.*, when she had so far recovered, that when disturbed she moved herself on her belly along the floor for about two feet, using the limbs as lateral paddles. 50 *min.*, rapidly recovering.
97	3 lb. 1 oz.	1-27	Death.	She walked across the room, wabbling, and placed her head in a corner. At 1 *min.*, she squealed sharply; the ears began to twitch. She fell on her side, and was seized with violent clonic convulsions, which lasted until 4 *min.*, when death ensued. The pupil at 2 *min.* had contracted from 7-20 to 2-20. As with all experiments with nicotin, the action of the heart continued after respiration had ceased.
98	3 lb. 2 oz.	1-20	Death.	After 1 *min.*, she lost all power over the hinder extremities, and, immediately after, over the front ones. 3 *min*, severe convulsions occurred, after which she lay quiet and motionless. 5 *min.*, she was lifted, and had a slight convulsion. 10½ *min.*, convulsions occurred, and were succeeded by complete paralysis. The respiration grew slower and feebler, and, at 23 *min.*, ceased.
99	3 lb. 13 oz.	1-14	Death.	1 *min.*, twitching of the ears, clonic convulsions. 3 *min.*, convulsions occurred, and were succeeded by paralysis of the entire body, excepting the head, since she moved the head and ears when the hind quarters were touched. 22 *min.*, convulsions set in violently, caused apparently by the irritation of a sudden noise. These continued at intervals until 34 *min.*, when one of them terminated in death. The respiration, from the beginning, was at times gasping, and at times comparatively easy.

III. *Effects of the Combined Action of Nicotin and Strychnia Sulphate on Rabbits.*

EXPERIMENTS 100, 101, 102.

(100) A rabbit, weighing 3 lbs. 4¼ oz., received Nicotin ♏1-50. Slight difficulty in walking, with prostration, and contraction of the pupil, ensued. In *one hour*, the animal had perfectly recovered.

(101) The same animal, 8 days after, received Strychnia Sulph. gr. 1-192. No result ensued.

Digitized by Google

(102) The same animal, 8 days after, received Strychnia Sulphate gr. 1-192, together with Nicotin ♏1-50. The symptoms were the same as in Experiment 100.

EXPERIMENTS 103, 104, 105.

(103) A rabbit, weighing 3 lbs. 5 oz., received Nicotin ♏1-50, with the same result as in Experiment 100.

(104) The same animal, 8 days after, received Strychnia Sulph. gr. 1-128, with no effect.

(105) Eight days afterwards, the two doses were given together, with the same effect as when the Nicotin was given alone.

EXPERIMENTS 106, 107, 108.

(106) A rabbit, weighing 3 lbs. 14½ oz., was given Nicotin ♏1-50, with the same effect as in Experiment 100.

(107) The same animal, one week after, was given Strychnia Sulph. gr. 1-109, with no effect.

(108) After 8 days, the two doses were given together, and produced prostration, stiffness, noisy and labored respiration, with increase of reflex excitability.

EXPERIMENTS 109, 110, 111.

(109) A rabbit, weighing 3 lbs. 14½ oz., received Strychnia Sulph. gr. 1-74. In 15 *min.* was accidentally struck by a door, and had a tetanic convulsion. 28 *min.* Perfect recovery.

(110) The same rabbit, 8 days afterwards, received Nicotin gr. 1-35. 3 *min.*, stiffness; difficult respiration. 15 *min.*, limbs almost completely paralyzed. 1½ *hour*, recovery.

(111) The same rabbit, after an interval of one week, received the two doses combined. After 2 *min.*, walked with difficulty; respiration labored. 10 *min.*, sat quiet, quivering occasionally. 35 *min.*, tetanic convulsion, and death.

EXPERIMENTS 112, 113, 114.

(112) A rabbit, weighing 3 lbs. 11½ oz., received Strychnia Sulph. gr. 1-96, alone, and with no result.

(113) The same animal, 7 days afterwards, received Nicotin ♏1-30. Marked prostration and difficulty in breathing resulted.

(114) After an interval of a week, the two doses were given combined. In addition to the symptoms mentioned under Experiment 113, a slight convulsion occurred.

EXPERIMENTS 115, 116, 117.

(115) A rabbit, weighing 3 lbs. 11 oz., received Strychnia Sulph. gr. 1-82, with no result.

(116) The same animal received Nicotin ♏1-30, with the same results as in Experiment 113.

(117) After one week, the two doses were given combined. 2 *min.*, dif-

Digitized by Google

ficult respiration; prostration. 8 *min.*, he lay with the extremities stretched out, powerless, his nose touching the ground. 1 *hour*, convulsive jerking. 70 *min.*, tetanic convulsion. 71 *min.*, brief clonic convulsion. Recovery.

Experiments 118, 119, 120.

(118) A rabbit, weighing 3 lbs. 11½ oz., received Strychnia Sulph. gr. 1-77, with no effect.

(119) The same animal, received Nicotin ♏1-30, with the same effect as in Experiment 113.

(120) One week after, the above-mentioned doses were given together to the same animal. For 22 *min.*, nothing was noted, except difficult locomotion, and prostration. Then two clonic convulsions occurred, in quick succession. 30 *min.*, clonic convulsion. 31 *min.*, tetanic convulsion, and death.

D. *On Dogs.*

Effects of the Combined Action of Nicotin and Strychnia Sulphate on Dogs.

Experiment 121.

A dog, weighing 2 lbs. 3 oz., received Strychnia Sulph. gr. 1-96. After 12 *min.*, the only symptom noticed was stiffness in walking. Nicotin ♏ 1-400 was now given; immediately, the stiffness of the extremities became so marked that it was almost impossible for the animal to walk. He lay down on his side, and, at 14 *min.*, had a violent clonic convulsion, lasting 1½ minute. At 15½ *min.*, Nicotin ♏1-400, was again injected. The animal continued to lay on the side powerless; the respiration became more and more feeble; there was convulsive twitching of the body; and death ensued, at 24 *min.*

Experiment 122.

A dog, weighing 4½ lbs., received Strychnia Sulph. gr. 1-72. 3 *min.*, no symptoms. Nicotin ♏1-400 was given. 6 *min.*, respiration labored, panting. 9 *min.*, he is very stiff; respiration the same. Nicotin ♏1-400 was again injected. 11 *min.*, irregular convulsions, during which Nicotin ♏1-400 was injected. The convulsion ceased at the 12*th min.*, but the animal still lay extended on the side, the respiration became less and less frequent, and ceased at the 14*th min.*

Experiment 123.

A dog, weighing 6½ lbs., received Strychnia Sulph. gr. 1-32. 6 *min.*, no symptoms. Nicotin ♏1-200 was now injected. The respiration immediately became somewhat labored. 13 *min.*, tetanic convulsion. Nicotin ♏1-200 injected. Immediately after the injection, a second tetanic convulsion occurred; shortly afterwards, a third. 16½ *min.*, death.

Experiment 124.

A dog, weighing 2½ lbs., received Strychnia Sulph. gr. 1-192, and Nicotin ♏1-96, by a single injection. 30 *seconds*, slow, panting respiration.

Digitized by Google

Pupils contracted; nictitating membrane drawn over the cornea. 35 *seconds*, he staggered a few steps, fell on the side, and in 1½ *min.* was seized with powerful tetanic convulsions, which terminated life at 4 *min.*

Experiment 125.

A dog, weighing 7 lbs., received Strychnia Sulph. gr. 1-32, with Nicotin ♏1-200. 1 *min.*, labored respiration. 7 *min.*, slight convulsion. 7½ *min.*, Nicotin ♏1-200 given. 8 *min.*, respiration labored and noisy. 9 *min.*, tetanic convulsion. 10 *min.*, Nicotin 1-200 given. 14 *min.*, tetanic convulsion, and death.

Experiments 126, 127, 128.

(126) A dog, weighing 2 lbs. 10 oz., received Strychnia Sulph. gr. 1-192. The symptoms were rigidity of the limbs, and slight increase of reflex excitability, lasting till the 25*th min.*

(127) The same animal, 5 days afterward, received Nicotin ♏ 1-192. The symptoms (which lasted about 20 minutes) were slow, labored respiration, staggering gait, vomiting, salivation, contracted pupil.

(128) The same animal, after 7 days, received the two drugs together, in the doses detailed above. The symptoms were slow, labored respiration, great weakness, staggering walk, vomiting, salivation, contraction of pupil; several slight convulsions between the 12th and 18th *mins.* 20 *min.*, recovery.

Experiments 129, 130, 131.

(129) A dog, weighing 7 lbs., received Strychnia Sulph. gr. 1-48. It was followed by stiffness and increased reflex excitability. When irritated, feeble convulsions occurred.

(130) The same animal, after 5 days, received Nicotin ♏1-200. 2 *min.*, respiration very difficult; gait staggering. 7 *min.*, purging and vomiting.

(131) The same animal, 7 days afterwards, received the doses, detailed in Experiments 129 and 130, combined. 2 *min.*, difficult respiration, and staggering gait. 9 *min.*, vomiting; great rigidity. 12 to 20 *min.*, irregular convulsions occurred spontaneously; gradual recovery.

Experiments 132, 133, 134.

(132) A dog, weighing 5 lbs. 10 oz., received Strychnia Sulph. gr. 1-96. 15 *min.*, decided stiffness and difficulty in walking; somewhat labored respiration. 28 *min.*, recovering.

(133) The same animal, 6 days afterwards, received Nicotin ♏1-200, with the same effect as in Experiment 130.

(134) The same animal, 7 days afterwards, received the two poisons combined in the doses detailed above. 1½ *min.*, difficult respiration. 7 *min.*, stiffness. 8 *min.*, vomiting; convulsive movements. 12 and 15 *min.*, irregular convulsions. 32 *min.*, recovering.

Digitized by Google

EXPERIMENTS 135, 136, 137.

(135) A dog, weighing 2¾ lbs., received Strychnia Sulph. gr. 1-180, with the effects mentioned in Experiment 126.

(136) The same dog, 6 days afterwards, received Nicotin ♏1-192, with the effects described in Experiment 127.

(137) The same animal, 2 weeks afterwards, weighing then 4½ lbs., received the two poisons combined, in the doses mentioned in the two preceding experiments. 1 *min.*, panting respiration. 4 *min.*, lay quietly, as if exhausted. 12 *min.*, vomiting. 29 *min.*, decided rigidity. He stood with his head in a corner, moaning. Though the animal had much increased in weight, the symptoms were more marked than in the controlling experiments.

EXPERIMENTS 138, 139, 140.

(138) A dog, weighing 11 lbs., received Strychnia Sulph. gr. 1-48, with no effect.

(139) The same animal, after 6 days, received Nicotin ♏1-20. 1 *min.*, difficult respiration. 2 *min.*, staggering gait. 15 *min.*, recovering.

(140) The same animal, 7 days after, received Nicotin ♏1-20. Immediately, the animal became almost completely paralyzed, and breathed noisily and laboriously. 1 *min.*, Strychnia Sulph gr. 1-96 was injected. Clonic convulsions set in after a few seconds, and continued for 1½ minute. During the convulsion, a second injection of Strychnia Sulph. gr. 1.96 (making in all gr. 1-48) was given. 2½ *min.*, convulsions ceased; temporary cessation of respiration, which recommenced with a gasp, and for 5 minutes was very laborious and infrequent (5 to 10 per minute). During this time, the animal remained completely paralyzed and unconscious. 7½ *min.*, he staggered across the room; respiration improving; pupil contracted, and nictitating membrane drawn. 21 *min.*, the animal now stood in a stiff, uneasy attitude, quivering very much when touched, and every minute running across the room, howling, slightly convulsed. 38 *min.*, he was lifted slightly with the foot, and fell over on his side in a violent clonic convulsion. After this, no more convulsions occurred. The animal gradually recovered.

EXPERIMENT 141, 142, 143.

(141) A dog, weighing 14 lbs., received Strychnia Sulph. gr. 1-24. It was followed by marked increase of reflex excitability, lasting 75 minutes. The animal barely escaped a convulsion.

(142) The same animal, one week after, received Nicotin ♏1-20, with the effects noted under Experiment 139.

(143) The same animal, one week after, received the two poisons combined, in the doses just detailed. 5 *min.*, difficult respiration, great rigidity, vomiting. 15 *min.*, severe clonic convulsions lasting two minutes. 23 to 35 *min.*, he had numerous convulsions, but none strong enough to cause him to fall. Then a powerful tetanic convulsion occurred; then the same condition of semi-convulsion was noted; and at 45 *min.*, another tetanic convulsion, and death.

Digitized by Google

Remarks.

The recorded cases of Strychnia poisoning treated by Tobacco are extremely unsatisfactory. If they prove anything, it is merely that Tobacco is a powerful emetic.

Haughton's experiments on this subject (really only two in number) were performed in such an unscientific manner as to be utterly valueless.

Wormley's and Reese's experiments would certainly seem conclusive, were it not for the fact that the drugs were administered by the mouth: therefore, since vomiting so generally occurred, we cannot feel certain that the tobacco infusion was absorbed with sufficient rapidity, or in sufficient quantity, to exert any possible antidotal power.

From the experiments given in detail in the preceding pages, the following inferences may, I think, safely be drawn:

1. Strychnia and Nicotin are in no degree antagonistic poisons.
2. Strychnia increases the convulsive action, and does not diminish the motor paralysis, of Nicotin.*
3. Nicotin (even in paralyzing doses) increases the convulsive action of Strychnia.†
4. Both poisons cause death by paralyzing the respiratory apparatus. They may effect respiration in different ways, but the result is the same.
5. Animals may be killed by injecting together doses of the two drugs, which, singly, are not fatal.‡

There is no reason to suppose that the above deductions are not applicable to the human animal. The symptoms of poisoning by the two drugs are identical in man and the lower animals. As regards Strychnia, this is too well known to need further remark. In regard to Nicotin, it is only necessary to refer the reader to the recorded cases of poisoning by that drug.§

It may not be out of place to mention the fact that experimentation has proven that Nicotin and Strychnia show a remarkable similarity in their intimate action on the nervous system, both being excitants of the spinal

* Exps. 25, 27, 28, 29, 30, 42, 43, 44, 45, 46, 88, 111, 131, etc.

† Exps. 81, 83, 85, 88, 114, 117, 128, 131, 140, 143, etc.

‡ Exps. 88, 111, 120, 143, etc.

§(1) A man, who had swallowed a mouthful of tobacco, became suddenly and completely *paralyzed; convulsions* set in; then *vomiting* and *purging;* and he finally died of exhaustion. (*Edin. Medical Journal*, Vol. I., p. 643.)

(2) A man received an enema of an infusion of two ounces of tobacco. In seven or eight minutes, he became pale and stupid; his speech was indistinct; and he c mplained of pains in the abdomen and head. There were *convulsive tremors*, first of the arms, then of the body. These symptoms were followed by *extreme prostration, and slow, laborious breathing;* then by coma, which terminated by death eighteen minutes after the poison had been injected. (*Tavignot, Gazette Med. de Paris*, Nov. 1840, p. 763.)

(3) Stillé gives the following symptoms in a case of poisoning by tobacco, in the person of a young woman: Slow respiration, coma, opisthotonos, with clonic convulsions of the extremities, dilated pupils. (*Therap. and Mat. Med.*, Vol. IV, p. 325.)

(4) A man sat over a chamber-pot containing some tobacco, on which hot

cord, and paralyzers of the motor or efferent nerves.* For the explanation of these assertions, and for many other deeply interesting facts connected with this subject, the reader is referred to other sources.

On the Brain of Coryphodon.

By E. D. Cope.

(*Read before the American Philosophical Society, March* 16, 1877.)

The character of the brain in *Coryphodon* being an important desideratum, I endeavored to obtain a cast of the cranial cavity of a well preserved skull of a *C. elephantopus*, from the Wasatch beds of New Mexico. The hard sandstone matrix which filled it, was removed with some difficulty; the more as its surfaces were indurated by a cement containing much iron oxide. The osseous walls were found in a good state of preservation. It was ascertained that there is a considerable *foramen lacerum posterius*, but which is not nearly of such proportionate size as that in the genus *Tapirus*.

The form of the brain-cast thus obtained is very remarkable. Its distinguishing peculiarities are, (1) the small size of the cerebellum; (2) the large size of the region of the corpora quadrigemina; (3) the small size of the hemispheres; and (4) the enormous size of the olfactory lobes.

There is in the cast a strong constriction in front of the *medulla oblongata* on one side, which does not exist on the other side. It is uncertain which represents the true form, as regards the lateral portion, but that there was a step-like constriction across the base of the brain at this point, there is no doubt. The medulla is very stout and wider than the hemispheres; it is depressed, and a protuberance on the inferior part of each side has the appearance of the base of the eighth pair of nerves. The region of the cerebellum is depressed and does not present in the cast a distinct line of demarkation from the medulla. An indication of the vermis is seen in a low longitudinal median protuberance. In front of this a transverse shallow depression separates it from the middle brain.

The region of the *corpora quadrigemina* is the most bulky portion of the

coals had been placed. After sitting a few minutes he became completely paralyzed, and showed no signs of life, except a deep sigh every fifteen or twenty seconds. (*London Med. Gaz.*, Oct. 1846, quoted by Stillé, *Op. Cit.* p. 324.)

(5) Taylor states that in a case of suicide by nicotin, that the person "became insensible and powerless within a few seconds, and died in from three to five minutes; without convulsions."

A reference to the experiments related in the text, will show the entire similarity of the action of tobacco on man, to its action on the lower animals.

*H. C. Wood's Therapeutics, pp. 284, 340, 341.

Digitized by Google

brain. Superiorly it presents a large transverse tuberosity, with the lateral portions well defined, but not distinguished from the cast of the hemispheres on the median line. From its latero-superior prominences it extends downwards and forwards on each side, expanding laterally and narrowing as it approaches the inferior surface. Each lateral portion is separated from the hemisphere by a deep fissure, into which a prominent crest of the lateral cranial walls projects. This crest commences above, nearly at the plane of the superior wall, and curves downwards and forwards to below the middle of the cavity which contained the hemispheres. The inferior face of the middle region of the brain is bounded laterally by the projecting masses above described, posteriorly by the constriction in front of the medulla, and anteriorly by a slight contraction marking the boundary of the hemispheres. Its anterior lateral angles are continued into a fossa of the cranium, which I did not clear of the matrix, but which doubtless gives exit to the *foramina sphenoörbitale* and *rotundum*. The protuberance which occupies this fossa here, includes the base of the trigeminus nerve. A short distance posterior to this position on the inferior side of the lateral expansion of the middle brain, is the slight projection which covers the cavities of the *foramen ovale* and the *foramen lacerum posterius*. Between these on the middle line, is a pair of longitudinal elevations divided by a median longitudinal depression. Posteriorly they rise from the transverse constriction of the medulla; anteriorly they terminate rather abruptly, the one half at a point anterior to the other. This assymmetry is found in the osseous basis cranii, and is not due to accident. This median ridge is separated by a wide, shallow concavity from the lateral border on each side. A short distance anterior to the *foramen sphenoörbitale* is a small fossa which I have not explored, but which is the opening of the *foramen opticum*. They are of small size, indicating a corresponding character for the optic nerve.

The *cerebral hemispheres* are relatively and absolutely very small, their median long diameter being one-fifteenth the total length of the skull, or a little smaller than those of the *Uintatherium mirabile*, according to the figures and description of Marsh. They are together about as wide as deep posteriorly, but both diameters diminish rapidly forwards, the vertical the most rapidly. The profile slopes downwards and forwards to the base of the broad olfactory peduncles. There are no convolutions nor any decided indication of the Sylvian fissure,* but there are surface-casts of the small arteries that ramified in the dura mater. Owing to the prominence forwards of the inferior part of the middle brain, but a small part of the inferior surface of the hemisphere is visible. The olfactory lobes are the largest known among *Mammalia*, and greatly exceed those of *Uintatherium*, as described by Marsh, and even those of *Oxyæna*. Their peduncle is transversely oval in section, and is directed horizontally forwards for a

* Prof. Marsh (Amer. Journ. Sci. Arts, 1876, p. 166) states that both convolutions and a Sylvian fissure are present in *Uintatherium*. These assertions are not justified by his figures, nor by the probably similar brain of *Coryphodon*.

Digitized by Google

distance about half as great as the length of the hemispheres without change of form. The mass then expands laterally and superiorly, rising upwards on each side of an osseous septum, which does not divide the olfactory lobes to the inferior face. They are thus deeply grooved above, and finally become furcate near to the extremity. Posterior to this point the inferior face rises, and the apices project laterally and forwards from the superior part of the lobe. The olfactory lobes consist, then, of a massive peduncle supporting a grooved subconical enlargement, which is bifurcate at the apex.*

Since the internal walls of the skull show the foramina for the exits of the cranial nerves, we have a sufficient basis for the determination of the parts of the brain. In this attempt we are met by the difficulties which are inherent in the use of a cast to represent a brain. Although the *foramina sphenoörbitale* and *rotundum* can be readily fixed, their position is such as to give the point of exit of the nervus trigeminus an unusually inferior position. This appears to be the case to a still greater extent in the *Uintatherium*,† where the lateral descending masses are at the same time not nearly so largely developed as in *Coryphodon*. The large inferior area enclosed between these boundaries is then homologous with the *pons varolii* or that part of the encephalon which is covered by it. Its appearance in *Uintatherium* supports this identification, but its proportions and anterior position in *Coryphodon* depart more widely from the usual form. The two anterior submedian ridges of its surface, faintly indicated in *Uintatherium*, may be the homologues of the pronounced median ribs in *Coryphodon* which resemble a continuation of the anterior pyramids of the medulla oblongata. As they are not very distinctly marked in the medulla of *Coryphodon*, their identification may be uncertain, but they look like that portion of the anterior pyramids which is continuous with the crura cerebri, and which are concealed in *Mammalia* by the pons varolii. Their prominence in *Coryphodon* indicates that the pons is wanting in this genus as in the *Reptilia*. A shallow concavity of the sphenoid bone between the origins of the trigemini indicates the position of a pituitary body or hypophysis.

In profile the brain closely resembles in form that of a lizard, *e. g.*, an *Amiva*, excepting that in the latter the cerebellum is more elevated. The extension downwards and forwards of the middle brain with its projection below the hemispheres is common to both, but the inferior portions at least, do not appear to be homologous in the two. In the *Coryphodon*, the lateral projections correspond with the exits of the trigeminus from the skull; in the *Amiva* this part terminates in the optic tracts. The superior portions of the middle brain correspond in appearance and relative size with that of the *Amiva*, but a clear difficulty in identifying them in the

* Measurements of this brain are given in the article on *Coryphodon elephantopus*, in my forthcoming report on the vertebrate Paleontology of New Mexico, Vol. IV, of the report of Lieut. G. M. Wheeler.

† See Amer. Journ. Sci. Arts, 1876, pl. iv, p. 165.

Digitized by Google

two types, is derived from the difference in their inferior connections. One result of the examination is assured, viz.: that this region is no part of the cerebral hemispheres, and that it is entirely uncovered by them. As it is not the cerebellum, it stands in the position of the corpora quadrigemina, or perhaps the posterior pair more especially. As the homologies of this region in the vertebrate brain are not yet determined, further attempts to identify this part of it in the *Amblypoda* must be postponed for the present. The structure is in any event entirely different from that seen in any recent *Mammalia*, or in any Mammal of a period more modern than the Eocene period, and one that not only entitles these animals to a position in a peculiar order, but also in a special division of the class, even more distinct than those based by Prof. Owen on the modifications of the structure of the brain. The homologies of the olfactory lobes are simple, but their extent and form resembles nothing known among mammals, even far exceeding in size those of *Uintatherium*. On the other hand, they resemble those of reptiles, especially of the lizards, but are less deeply bifurcate anteriorly than in them. In the *Coryphodon elephantopus* they equal in length the middle brain and hemispheres together, and their bulb equals the hemispheres in transverse and vertical diameter.

The nearest approach to the form of the brain in the *Amblypoda*, is seen in that of the *Arctocyon primævus*, a Creodont which represented the *Carnivora* in the same lower Eocene fauna, and was actually associated with *Coryphodon* in France. This brain is described and figured by Prof. Gervais, Nouv. Archives du Muséum, vi., 1870, p. 150, Pl. 6 f. 4, who notices the remerkable exposure of the middle brain or corpora quadrigemina. Among *Mammalia* of later ages some of the extinct South American *Edentata*, present the greatest resemblances, although slight ones. Among these may be noticed the small and transverse cerebellum, and especially the lateral expansion of the region anterior to it. To what portion of the brain this expansion belongs, is not known, but it is not unlike the lateral mass in *Coryphodon*, as, *e. g.*, in the *Eutatus seguini*,* Gervais. There is, however, nothing exposed on the superior surface in the Edentata which appears to be the middle brain; hence the difference from the brain of the *Amblypoda* is very considerable.

In reviewing the evidence brought together up to the present time, the writer is of the opinion that the type of brain shown to exist in the *Amblypoda*, and *Creodonta*, is as distinct from those characterizing the primary divisions of the *Mammalia*, as they are from each other; and that it necessitates the establishment of a special sub-class for their reception of at least equal rank with the groups *Gyrencephala*, *Lissencephala* and *Lyencephala*. This may be called *Protencephala*, with the following definition: Cerebral hemispheres smooth, small, leaving not only the cerebellum but the middle brain exposed behind, and contracting into the

*Figured in the important Memoir of Gervais, already quoted, Nouv. Arch. Mus., 1869, v., p. 42.

Digitized by Google

very large olfactory lobes in front. Cerebellum very small and flat; middle brain large. This character is sustained by that of the ankle joint, which, existing in two such distinct divisions as the *Amblypoda* and *Creodonta*, may be found to characterize the entire sub-class, but this is not yet certain; it is as follows: Tibio-astragalar articulation flat, and without groove or segment of pulley.

This sub-class stands below the *Lyencephala* in its position, approximating the reptiles in the points above mentioned, more nearly than the latter do. It includes two orders, one ungulate, the *Amblypoda*, the other unguiculate, the *Bunotheria*.* To the former belong the sub-orders *Pantodonta* and *Dinocerata;* to the latter the *Creodonta* and probably the *Tillodonta* and *Tæniodonta*. Whether the *Mesodonta* belong to it is not certainly ascertained, while the *Insectivora* do not belong to it, as they are rightly placed in the sub class *Lissencephala*.

Lartet first pointed out the fact of the successive increase in the size of the brain of the *Mammalia* with the advance of Geologic time; and Marsh has stated that this increase is to be observed principally in the relative size of the cerebral hemispheres. I would correct the latter statement so far as to add, that the increase of size is to be seen in the cerebellum as much as in the hemisphere. It is also evident that the relative decrease is in the middle-brain and olfactory lobes.

Explanation of Plates.

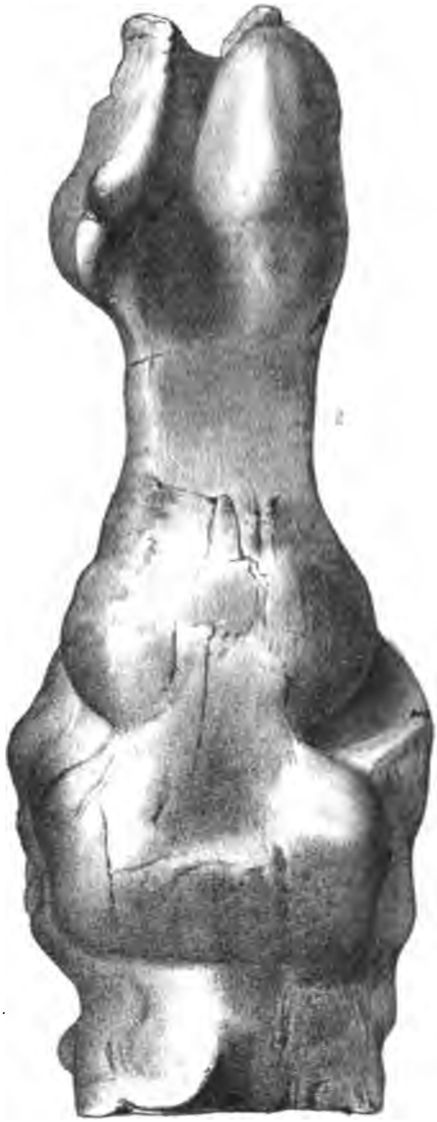
Pl. I. Cast of brain cavity of *Coryphodon elephantopus*, two-thirds the natural size. The right bulbus of the olfactory lobe is probably too large above, owing to the want of preservation of the superior wall of the cavity.

Fig. 1. Superior view; fig. 2, the left side; t. base of the trigeminus nerve.

Pl. II. The same. Fig. 1, from below; fig. 2, posterior; fig. 3, anterior views. t. base of the trigeminus nerve; md. base of the mandibular branch of the trigeminus; p, ribs continuous with anterior pyramids.

* See Proceedings Academy Natural Sciences of Philadelphia, 1876, p. 88.

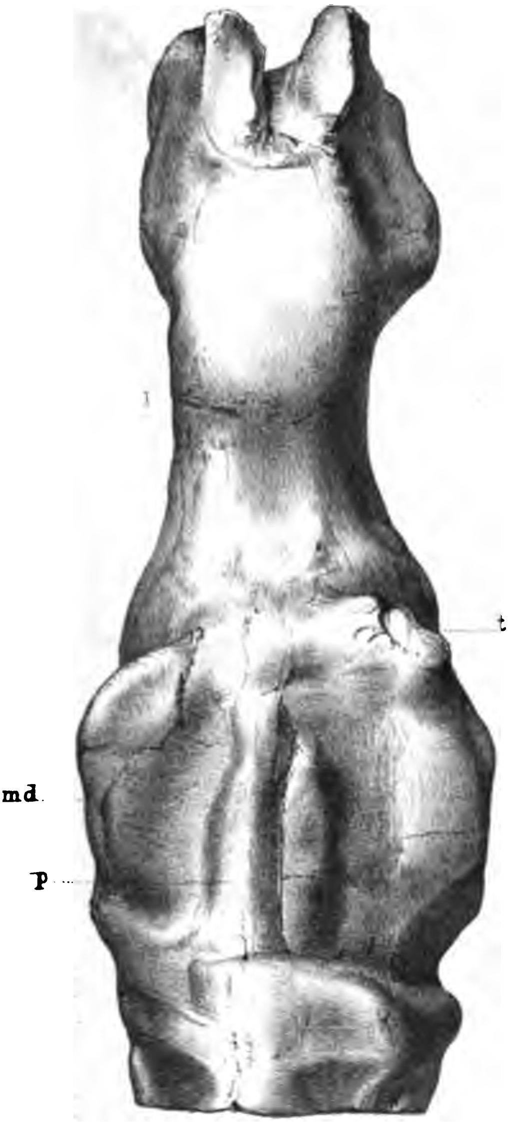
Digitized by Google



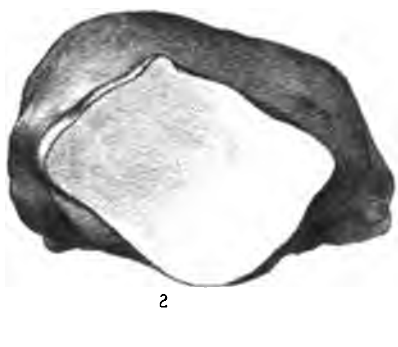
Coryphodon elephantopus ½

Digitized by Google
OF

Digitized by Google



3



2

Coryphodon elephantopus 2/3

Digitized by Google

Digitized by Google

Contribution to Palæontology from the Museum of the Second Geological Survey of Pennsylvania.

By Charles E. Hall.

(*Read before the American Philosophical Society April* 6, 1877.)

Genus Eurypterus.

Eurypterus; Dekay, Annals of the Lyceum of Natural History of New York, 1825, Vol. I, p. 375.

The geological horizon of Eurypterus has heretofore been confined to the Water-lime group, in the United States, although the genus has been recently discovered in the English coal measures.

The position of the Water-lime group is between the Onondaga salt group and the Lower Helderberg group, therefore Upper Silurian.

The Water-lime group in Pennsylvania is lithologically well defined, but has not yet, to my knowledge, furnished a single specimen of crustacea. In New York the group is characterized by the crustaceans Eurypterus, Pterigotus and Ceratiocaris.*

Bernician.

Eurypterus Pennsylvanicus (provisional. n. sp.)

In the collection of 1874, made under the direction of Mr. J. F. Carll, in Venango County, Pa., a perfect but indistinct carapace of an Eurypterus was found by his assistant Mr. Hatch.

The specimen agrees in general with Eurypterus remipes of the Water-lime.

Position and locality, in sandy shale overlying a sandstone, which is equivalent to the Garland Conglomerate, at Rooker Farm, Venango Co. Pa.

The horizon is in the transition series between the base of the *Carboniferous* and the top of the *Devonian*.

Carboniferous.

Genus Eurypterus.

Sub-genus Dolichopterus.

Dolichopterus Mansfieldi. (n. sp.)

Carapace semioral, wider than long, indented line visible along the anterior margin, lateral margins nearly straight for one-fourth the length, then evenly rounded; eyes prominent, kidney-form, situated a little forward of the centre of the carapace and about midway between a medial line and the lateral margins.

Body convex, the middle of the thorax slightly wider than the carapace, length of the joints increasing towards the terminal spine-like prolongation.

* See N. Y. Palæontology, Vol. III.

Digitized by Google

Entire surface covered by small, triangular, imbricating scales, decreasing in size towards the lateral margins; along the anterior portion of the carapace the scales are not visible. The paletti (one of which is preserved) long and narrow, being nearly twice as long as wide, and has the characteristic serrated margin, which is the principal distinguishing feature in the sub-genus. Length of specimen, without terminal joint, two and three-fourths inches; greatest breadth seven-eighths of an inch.

Position and locality. Found in the shale immediately below the Darlington cannel coal, near Cannelton, Darlington Township, Beaver Co. Pennsylvania. Horizon, Alleghany River Series.

We are indebted to Mr. S. F. Mansfield, of Cannelton, for this beautiful specimen, and after whom we deem it proper to name the species.

On the Relative Ages of the Sun and certain of the Fixed Stars.

By Professor Daniel Kirkwood, of Indiana University.

(*Read before the American Philosophical Society, April* 6, 1877.)

The doctrine that the light and heat of the sun are produced by the chemical combination of its elements was very generally accepted till about the middle of the nineteenth century. It has, however, been completely disproved by the labors of Dr. Mayer and Sir William Thomson. The quantity of heat radiated by the sun in a given unit of time has been determined with approximate accuracy. The amount produced by the combustion of a given quantity of coal is also known. From these data it is easily shown that if the sun were a solid globe of coal, and a sufficient supply of oxygen were furnished to support its combustion, the amount of heat resulting from its consumption would be less than that actually emitted within historic times. "Take (in mass equal to the sun's mass) the most energetic chemicals known to us, and in the proper proportion for giving the greatest amount of heat by actual chemical combination; and, so far as we yet know their properties, we cannot see the means of supplying the sun's present waste for even 5,000 years."* The chemical theory is accordingly given up as wholly untenable.

What then is the source of solar energy? To this interesting question, in the present state of our knowledge, but one reply is possible. The great law of the conservation of force—one of the most important discoveries in the history of physical science—points at once to a cause which is adequate both in mode and measure. Motion may be transformed into heat, and *vice versa*. The heat produced by the fall of a given quantity of matter upon the sun from the outer limits of the solar system would be 7,000 times greater than that resulting from the combustion of its own weight of coal. In the mechanical theory of solar energy, as advocated by Helmholtz and

* Tait's Recent Advances in Physical Science, 2nd Ed. p. 152.

Digitized by Google

now generally accepted, the sun's heat is produced by the falling together or condensation of the matter of which its mass is composed. But the rate of solar radiation and also the mechanical equivalent of heat are known. With these as data it may be easily calculated that a contraction of the sun's radius amounting to one mile in 40 years would be sufficient to keep up the present supply of heat. At former epochs, when the volume was greater and the density less, a more rapid contraction was necessary to keep up the supply. If the sun, or rather the solar system originally existed as a nebulous mass, with a radius equal to half the distance of the nearest fixed stars, the total amount of heat generated by contracting to its present dimensions would have kept up a supply, equal to that now dispensed, for about 20 millions of years. This period, it will be observed, includes the entire physical history of the solar system, from Neptune down to Mercury. It must be liable however, to considerable uncertainty, as it assumes the radiation of heat to have been uniform.

Before attempting a comparison between the ages of the sun and certain of the fixed stars it should be premised that from the epoch of incipient solidification, or rather of incipient transition from the gaseous to the liquid form, the quantity of motion in the contracting mass, and consequently the amount of radiant heat, must gradually diminish. Many of the nebulæ and some of the fixed stars have not reached this epoch ; while the sun, 61 Cygni, and the companion of Sirius, as will be shown hereafter, have probably passed it. Our first comparison will be that of

The Sun and Alpha Centauri.

The larger component of the double star Alpha Centauri is of the first magnitude ; the smaller one, of the second. The color of both has been described as dark orange. According to Hind,* the system completes a revolution about its centre of gravity in 85 years ; the mean distance between the components being 23.49 times the radius of the earth's orbit—somewhat greater than the distance of Uranus from the sun.

Of all the fixed stars whose distances have been measured, Alpha Centauri is the nearest to us. Its annual parallax is $\frac{928}{1000}$ths of a second, which corresponds to a distance 7336 times that of Neptune from the sun : —so completely isolated in space is our planetary system.

The apparent magnitude of Alpha Centauri is greater than that of any star in the Northern Hemisphere ; and of those South of the equator but visible in our latitude, Sirius alone surpasses it in splendor. Its mass is nearly the same with that of the sun ;† while the intrinsic light and heat of the system are nearly three times greater. It may be inferred from these facts that the sun has probably passed the epoch of greatest heat, and that it is farther advanced in its physical history, or, in other words, is an older star, than Alpha Centauri.

*Monthly Notices of the R. A. S., for January, 1877. These elements differ materially from those previously found.

†Hind's recent value is *greater* than the sun's mass; all former estimates *less*.

Digitized by Google

61 Cygni.

The annual parallax of 61 Cygni is $\frac{46}{100}$ths of a second, which corresponds to a distance 448,000 times that of the earth from the sun. The magnitudes of the components are 5½ and 6; their distance from each other is 45 times the radius of the earth's orbit; their period, about 500 years; and the sum of their masses, rather more than one third of the sun's mass. They have the same color—a golden yellow.

The mass of the larger component of 61 Cygni may be taken at one fifth of the sun's mass. According to the estimate of Sir William Herschel the light of an average star of the first magnitude is 50 times that of a star of the fifth, or about 75 times that of the larger component of 61 Cygni. The intrinsic light of the principal member of Alpha Centauri being twice that of the sun and 75 times that of A, 61 Cygni, we obtain the following relations:

	Sun.	A. 61 Cygni.
Surface, (densities equal?)	3	1
Mass	5	1
Intrinsic light	9½	1.

These numbers seem to indicate that 61 Cygni is farther advanced than the sun in its physical history.

Sirius.

"It has been long acknowledged," says Humboldt, "that of all the brightest luminous fixed stars of heaven, Sirius takes the first and most important place, no less in a chronological point of view, than through its historical association with the earliest development of human civilization in the valley of the Nile." The recent discovery of its binary character, together with the determination of its parallax, mass, motion, and constituent elements, have greatly enhanced the interest with which this star is regarded by the scientific public. From the meridian altitudes of Sirius, as observed by Sir Thomas Maclear, at the Cape of Good Hope during the years 1836 and 1837, Dr. Gylden, of Pulkowa, has found its annual parallax to be $\frac{193}{1000}$ths of a second, which corresponds to a distance 1,068,700 times that of the sun from the earth. The light of this star is therefore 16 years in reaching us.

The orbit of this binary system has been computed by Dr. Auwers, who finds the period of revolution to be 49 years and 146 days; the semi-axis major, 37 times the distance of the earth from the sun; and the eccentricity, 0.6148,—somewhat greater than that of Fays's comet. The mass of the companion is half that of the principal star; or more accurately, the mass of Sirius is 13.76, and that of the telescopic star, 6.71, the mass of the sun being unity. According to the photometrical experiments of Sir John Herschel, the light received from Sirius exceeds that of Alpha Centauri in the ratio of 25 to 6. Comparing, therefore, the distances of the two stars, we find the intrinsic light of Sirius to be 93 times that of Alpha Centauri,

Digitized by Google

or 279 times that of the sun. The relative quantity of heat emitted by the different bodies may be assumed to have the same ratio.

But while the mass and distance of Sirius have been ascertained within moderate limits of error, the degree of its condensation, as compared with that of the sun, is still undetermined. On the hypothesis of equal density the light emitted from the sun would be but $\frac{1}{48}$ th part of that radiated from an equal portion of the star's surface. But, if equal areas of the two bodies afford equal quantities of light, then the volume of Sirius is 4661 times that of the sun, and the mean density of the latter is 333 times that of the former. It seems probable, therefore, that the principal component has still chiefly, if not entirely, a gaseous constitution.

As the light of Sirius, according to Sir John Herschel, is 324 times that of an average star of the sixth magnitude, and as the satellite discovered by Clarke is of the ninth or tenth magnitude, the light of the latter must be much less than one thousandth part of that received from the principal star. But according to Auwers the mass of the less component is equal to half that of the greater. Is it possible to explain these remarkable facts on the theory that the two bodies had a simultaneous origin in the same nebula, or has their present proximity resulted from the proper motions of two originally independent stars?

The conclusions apparently sustained by the facts here considered may be summarized as follows:

(1.) The history of the solar system is comprised within twenty or thirty millions of years.

(2.) From the fact of the larger component of Alpha Centauri radiates twice as much light as the sun while the mass of the former is *less* than that of the latter, we infer the probability that our solar system is the more advanced in its physical history.

(3.) 61 Cygni seems to have reached a greater degree of condensation than the sun, since, on the hypothesis of equal density, the surface of the larger member is one third that of the sun, while the intrinsic light is less than one ninth.

(4.) The companion of Sirius appears to have reached a stage of greater maturity than the sun, while the contrary seems to be true in regard to the principal star.

Bloomington, Indiana, March 26, 1877.

Digitized by Google

THE TIMUCUA LANGUAGE.

By Albert S. Gatschet.

(*Read before the American Philosophical Society, April* 6, 1877.)

The science of linguistics, glottics, or as it was at first called, of comparative philology, is of very recent date. Classical antiquity ignored it and it became a science only through the introduction of Sanscrit into the circle of those time-honored languages, of which the study was considered of importance. Modern geography, history, archæology and ethnology then availed themselves conscientiously and with signal success of this new help. One of the greatest triumphs obtained by linguistics is the disclosure of the primordial social state of the Semitic race and of our remotest Indo-European ancestors. Undoubtedly the antiquity of the two American continents could be disclosed by zealous scientists in the same manner, that is, by comparative researches on their languages, if reliable material is previously collected to a sufficient amount, so that the linguist can light his torch and proceed smoothly along the ethnological pathway of inquiry.

To similar researches I intend to furnish a small contribution by publishing some notices on the Timucua language, which is perhaps that idiom spoken within the present boundary of the Union in which the oldest writings of some extent have been published. As a nation, the Floridian Timucuas are now extinct, but their idiom is preserved in a shape which promises the possibility of its total restoration.

Historical and Ethnological Remarks.

At the time of its discovery the Floridian peninsula was inhabited by four principal and a number of minor nations, engaged in continual warfare among themselves. The Apalaches dwelt from the Suwannee River down to Tampa Bay; the southwestern coast was held by the ferocious Colusas, the southeastern parts and the Bahama Islands by the Tegestas, while nations speaking Timucua dialects extended from the neighborhood of Cape Cañaveral to the mouth of St. John's River and occupied many regions of the interior.

To avoid errors we must carefully distinguish between the three areas of territory to which the name Timucua is at present applied.

First, we have the area of the original Timucua tribe and of its dialect, around San Augustine. It is called by the early writers "Provincia timuquana."

Secondly, we have the area of a commonwealth of vassal-chiefs centralized under one monarch, of which the above Timucua tribe formed a portion, and was probably its most powerful part. For want of another historical or more comprehensive name this oligarchic commonwealth or monarchy was called by the same name of Timucua.

Thirdly, we have the area of the *language stock*, to which the dialect of the Timucua tribe belonged. This area has probably extended far beyond

Digitized by Google

the limits of the Timucua monarchy, but at the present time it is not possible to state its domain even by a rough approximation.

The name is written by the Spanish chroniclers Timagoa, Timuca, Timucua, Timuaca; by French authors Thimagona; by the English Tomoco, Atimuca, and contains the word *atimoqua*, which occurs in Pareja's books, f. i. in the Confessionario, on page 205, meaning *lord*, *ruler*.

In the sixteenth century the native population of northeastern Florida was governed by small chiefs, each of them ruling with absolute power over one or a few settlements laid out in the shape of corrals. These diminutive princes (or *olata, holata*) depended from a monarch in the same manner as the vassals of mediæval times depended of their suzerain or liege lord. To judge from the numerous revolts against their supremacy, the rule of the Timucua suzerain must have been rather despotic and arbitrary. His title was Paracussi, and, when spoken of in his quality as war-chief, Urriparacussi, *urri* or *iri* meaning war. His residence on Lake George seems to have been stationary; the name given for it by the chroniclers, *Utina* or *Utinama*, simply means "my country," and when used for the King himself it is abbreviated from *Paracussi Utina*.

We are informed by Barcia (*Ensayo*, page 48) that at the time of Réné Laudonnière's expedition, in 1564, forty vassal-chiefs obeyed the commands of this ruler. The tribe or province of the Timagoa was then governed by the Cacique Mollave, and the natives represented his territory to be rich in precious metals. Mollave was the vassal of a mighty king, of whose real name we are not apprized, though his title is given as *Olata Otina*, in Spanish "Señor de muchos Señores." This monarch wielded his sceptre over forty sub-chiefs, and the names of the most powerful of them are given as Chadeca, Chililo, Echonobio, Enacapen, Calanio, Anachatagua, Uvitaque, Aequeya, Mocoço. A chief named Potano-u was then rebelling against the Olata Otina, who was himself warring against another monarch, Soturiba, the commander of thirty caciques or sub-chiefs, and was forced by him to a disastrous and sudden retreat.

The following local names were collected from various sources and though I cannot vouch for the correctness of their orthography, I believe all of them contain words from the Timucua language: *Itara, Potano, Cholupaha, Caliquen, Napetuca, Hapaluya, Axille* (*Ausile*), *Salamototo, Ajohica, Tarahica, Alachua* (*Lachua*); and two river names: *Aquila* (reed, vine), *Ajano hibita chirico* (river of small acorns). Father Fr. Pareja quotes the provinces of *Mocama, Itafi, Timucua, Potano* and the "*Fresh-water-District.*" The westernmost town of the Timucua on the border of the Apalache country is given as *Asibe*, the easternmost of the Apalaches being *Ibitachuco*.

While it is difficult or impossible for topographers of our time to locate on our present maps most of the Floridian places mentioned in the sixteenth and seventeenth centuries, it is on the other side apparent that many local names surviving at the present time are of Indian origin, and that after obtaining a sufficient knowledge of the Timucua tongue we will be

Digitized by Google

enabled to trace the outlines of its ancient area through a careful analysis of these geographical terms.

Like the other Floridians, the Timucua were a people of large bodily proportions, lighter complexioned in the North, darker in the South, but exhibiting throughout that peculiar admixture to their cinnamon hue, which is called *olivâtre* by the French. For their subsistence they did not rely merely on the abundance of fish, eels and turtles, which peopled their rivers, ponds and lakes, but they also sowed the fields and hunted all sorts of game. Like other Indians they were addicted to polygamy, gross sensuality, sorcery and other superstitious practices, of which Pareja's books afford many curious examples. The population was divided in two portions, separated from each other in the strictest manner; the *nobility*, all of whose numerous pedigrees traced their origin to the sacred persons of the actual monarch or his predecessors, and the *common people*, which also preserved with piety the memory of its ancestors by long genealogical registers. No doubt an aristocratic spirit pervaded the civil and political institutions of these tribes, and if from this we are allowed to draw any conclusion referring to their antiquity, it would tend towards establishing a very protracted residence of the Timucua in these same regions, where the European explorers discovered them, and a comparative isolation and non-intercourse with surrounding nations.

For further ethnological information I refer to Dr. Dan. G. Brinton's "Notes on the Floridian Peninsula, its literary history, Indian tribes and antiquities, Phila. 1859," as well as to the writers on the ancient history of the country, as Basanier, Barcia, Bristock, Fontanedo, Herrera, Roberts, etc., and to the three chroniclers of the illustrious expedition of Hernando de Soto (1539—1543).

Only two writers are known to have composed books in the Timucua language; the priest Gregorio de Mouilla (of Mobile?) whose Doctrina Christiana is probably lost now, and the Franciscan Padre Francesco Pareja. Born at Auñon, in the Spanish diocese of Toledo, Pareja was with eleven other priests commissioned to Florida by the "Royal Council of the Indies," arrived there in 1594, converted many of the natives and founded the monastery (*custodia*) of Franciscans at St. Helena, 12 leagues North of San Augustine. In 1610 he removed to the city of Mexico, wrote a series of books, all of which were printed in Mexico, and died there January 25, 1628. Of his Grammar (Arte) and Dictionary (Bocabulario) of the Timucua and of some minor religious tracts in this language no copy is known to exist at present in any library, though some may turn up some time in Spain or in the Mexican States. I derived my information from two original Catechisms, bound in one volume, and from a Confessionario of Pareja, printed 1612 and 1613 in 16mo. and brought from Spain to New York by Mr. Buckingham Smith, once Secretary of the American Legation at the Court of Madrid. So careless and unreliable is the orthography of these texts and of the Spanish version standing opposite, that doubts arise whether Pareja himself, who, according to Hervas, lived at Mexico when

Digitized by Google

his writings were printed there, corrected and revised the proof sheets. The Spanish version is neither verbal nor faithful, often half, often twice as long as the Timucua text, and very frequently misleads the studious reader. Hence the utmost caution must be used in making researches on the idiom.

In spite of all these imperfections, Pareja's volumes are the most precious relics of Floridian antiquity. The texts often make two vocables out of one, or erroneously combine two distinct ones into one; but soon the student becomes accustomed to this caprice and enabled to righten the orthography himself. The books and titles are minutely described by Mr. B. Smith in New York Historical Magazine, 1858 and 1860, and on page 3, of the volume of 1858 he gives also some eighty Timucua words, mainly from the Confessionario, with their meanings. For the correctness of some of them I am unable to vouch. The *Tinqua* language mentioned by Ludewig (Literature of Am. L.), is a blunder, instead of the correct form *Timuqua*.

Phonetic Elements.

Timucua syllables are composed from single phonetic elements with remarkable simplicity. They either consist of a vowel only or more generally of a consonant followed by a vowel, and syllables terminating in an *s*, a nasal or other consonant are of rare occurrence (*hibuasta, manta*). The language has a quite numerous and complete series of sounds, and since Pareja does not use any diacritical marks on his Spanish letters, we might infer that it had about as many sounds as the Spanish alphabet, omitting the *ll, x, z* and *j*. *D* and *g* are scarce and of diphthongs none existed, excepting perhaps *au*. The *h* probably remained silent in most words where we find it, and stands there only to indicate hiatus of two vowels: *lehaue* for *le-aue*, *bohono* for *bo-ono*, and was equally silent at the beginning of words: *habosota; hachibono* (frequently written *achibono*). There was only one palatal *ch* (our *tch*) standing either for *tch* or for the softer *dsh*. *Qu* or *q* is our *k;* the *gu* or English *w*, so frequently occurring in Indian languages transcribed by Spaniards, does not occur here. Unfortunately the "*Arte*" of Pareja, which alone could inform us of his mode of transliteration authentically, is lost, perhaps forever, but from what we have we may safely conclude that no clicks, very rough guttural sounds or jaw-breaking clusters of consonants entered into the structure of this remarkably sonorous idiom, which possessed the following twenty-one articulations:

Vowels: u, o, a, e, i.
Consonants: k, g, t, d, p, b, tch, f, h, y, s, v, m, n, r, l.

In vocalism the nearest approximation to Timucua is made by some Polynesian tongues, f. i., that of the Sandwich Islands, by the Matlaltzinca or Pirinda of Michoacan and by the Tonto, spoken on middle Gila River, Arizona. Perhaps one-third of all words begin with vowels. The most frequent initial consonants are k, n, m, p. R and some other consonants do not begin any words, and it is somewhat doubtful if this r is our rolling

Digitized by Google

r, for this sound is extremely rare in Indian languages.* Our *sh* and *th* are wanting, but the *f*, not frequent in America, occurs here and in the Cháhta-Máskoki dialects, while Apalache shows no trace of it. (See specimen of this language in *Historical Magazine of New York*, 1860, page 40.) Very few instances occur, where a consonant is geminated (*ulipassa*), but with vowels this is very common. The surd pronunciation of a vowel is not distinguished in the texts from the clear and nasal one, but it is natural to assume that some of the *e*'s were what the French call *e muets*. Nasalizing is sometimes indicated by a final *n*.

The interchangeability of a class of consonants observed through all America is found also in Timucua and it would be singular indeed if we did not discover it in this peninsular idiom. The cause of this phenomenon must be sought for rather in the capacities of the auditory organ than in the structure of the vocal tube, we think. The following alternative processes are observed :

b and *v*,	*mobicho, movicho ; balu, valu.*
b and *m*,	*hachibueno, hachimueno.*
h and *f*,	*inihi, inifi.*
l and *r*,	*oyolano, oyorano ; tchiri, tchale.*
t and *d*,	*minta, manda.*

Alternating vowels :

ue and *o*	*hachibueno, hachibono.*

Pareja does not mark but exceptionally the emphasized syllable of a word, but we can safely assume that the accent rested on the radical syllable in words of three or less syllables, and that many particles were added *enclitically* to the words governing them. The elision of unaccented vowels occurs at times and then causes two consonants to follow each other.

INFLECTION.

Timucua incorporates particles of relation to a large extent and has also reached a considerably high degree of polysynthetism. The differentiation between verb and noun is not so thorough as in the Indo-European tongues, and we find that many particles of relation occur in both classes of words. These latter particles are *suffixed* to the radical syllable and prefixes are seldom found. Duplication of the root or of any other syllable is a rather uncommon means of grammatical synthesis, neither is it of frequent use in any of the eastern languages of North America.

The noun is inflected by means of postpositions and case-suffixes. The locative case is expressed by *-mi* : *pahami*, in the house, sometimes by *-la* : *acotala*, in the bed, or by *-ma* : *mocama*, in the sea. But this particle *-ma* is used to express the most diverse relations of the noun and also of the verb ; it does not only form plurals of substantives, but also possessive, dative, objective and other cases, and thus seems to be comparable in some respects

* Is it the sound *kh*, the Greek χ, which Spanish grammars of American languages render so often by R?

Digitized by Google

to the ubiquitous article-pronoun of the Cháhta language. Frequently other postpositions are placed between *-ma* and the word-stem, or after *-ma* as final syllables.

Other postpositions frequently occurring in the Timucua noun are: -co, -coco, -ke, -la, -le, -leta, -leke (-leqe), -ni, -no, -si, -so, -ta, -te, -ti, etc.

The demonstrative particle *na* is employed in many different ways. When placed before the noun, it serves as a definite article; when suffixed to it is the possessive pronoun "*my, mine.*" Owing to the indistinct pronunciation of unaccented vowels, which we observe sometimes in Pareja's texts, *na* appears also under the shape of *ne, nu; na* enters into the composition of the pronoun *ano,* "somebody, something, some one, one." *Ni* in *ni sikisama* means "*me;*" these words signify *my father*, and a literal translation would render them by "the one, who procreated me." *Ki* is here the radical syllable In his Catechism, page 18, Pareja gives the series of ordinal numbers which unfortunately runs no further than to seven: *Na* is prefixed to each of them as the definite article, and the ending *-mima* is the possessive pronoun of the third person singular: *his, her, its.*

Cardinals:	*Ordinals:*
mine 1	minecotamano, kibema
yucha 2	na yuchamima
hapu 3	na hapumima
cheketa 4	na cheketamima
marua 5	na maruamima
mareka 6	na marekamima
pikicha 7	na pikichamima
piqinahu 8	na piqinahumima
peqecheqeta 9	na peqecheqetamima
tuma 10	na tumamima
yahagala 11	
iuchaagala 12	
hapuangala 13	
chequetangala 14	
ero tuma yucho 21	
tuma hapu 30	
tumacheqetama 40	
itumacheqetoqe marua 45	
ero chupiaco iuchaagala 12,000	

In this series many terms are ending in *-a*; four is formed from two, *cha, che* appearing in both, and *ke* in "four" being an additive particle "together." We cannot decide as yet if the series is based on the quinary or simply on the decimal system of counting.

We often find appended to nouns, especially to substantives borrowed from the Spanish, the suffix *-mueno, -mono. Mueno* means "the name," or "to name, to call" and composes terms like *muenolete* is called, *hachibuena, hachimueno* "which thing? which? what?" (literally: which

Digitized by Google

name?) In the Spanish word *fémono* it means : the *so called* faith, in *gato-mano* the *so called* cat.

The termination *-male* serves to designate two members of a family equidistant in their relationship or consanguinity, f. i., father and son, grand-grand-father and grand-grand-child etc. The former two are called *itimale*, the latter *muulmale* ; but if the grand-grand son is mentioned before the grand-grand-father, another term, *kisitomale*, will be employed. Uncle and nephew is *itelemale*, nephew and uncle, however, are called *kiemale*. It will be difficult to find any other language on the face of the globe, even in America, where the degrees of relationship are distinguished with such extreme accuracy.

In a community with so aristocratic forms as that of the Timucua we must expect to meet with a number of *reverential* endings appended to nouns and verbs, which were used in addressing persons who commanded respect through their position : kings, chiefs, governors, parents, friends, matrons, etc. They are extremely frequent in the idioms of the Mexican States.

A demonstrative pronoun *caki* occurs in very different forms (*ca*, *caqe*, *caqui*, etc.), and answers to our *that* and to the personal pronoun *he*, *she*, *it*. Connected with the prefix *o* it occurs as *oque*, *oqe*, and its plural forms are *care*, *carema*, *oquere*, *oquare*. Etymologically connected with it is the demonstrative particle *-co*, frequently redoubled to *coco* and appended to substantives and adjectives. *Acu*, *ico* means every one, all ; *ano paracusi olata ico*, lit. "one king of all chiefs," was the official title of the Timucua monarch or head-centre.

When standing at the end of the sentence, as in questions, "*thou*" is expressed by *cho*, otherwise by *chi*, and in locutions like *chi isucu?* are you a herb-doctor? it replaces at the same time our substantive verb *to be*, of which all American languages are deficient. *Itimi isomikene chi nahe?* Have you father and mother? *Anoco orobasobi cho?* Did you bewitch anybody? The former sentence shows the use of the postposition *ke*, which in fact answers to our "and," but really signifies "together, along with," thus fulfilling the function of one of our prepositions.

The interrogative pronoun or particle who? what? which? *cha? acha? hacha?* appears chiefly in compounds, formed with different parts of speech. Most frequently the particle *ke* just spoken of is connected with it.

hacha chi mueno? which is thy name?
chanco (contracted from chanaco)? whence? wherefrom?
hachamueno (see *supra*).
hachakene? which? and which? and what?
hachakenenco, hachakenike? and why?
hachakenta, hachakentana? how? how then? and how? in which manner?

Verbs are derived in various ways from substantives, adjectives, or from other verbs. Some of the principal derivational endings, particles or forms are as follows :

Digitized by Google

-lehaue forms causative verbs: *ituhu* to pray over, enchant, bewitch: *ituhu-lehaue mobi cho?* Did you order (the sorcerer) to pray over (something)?

-letahaue involves the idea of duty, or obligation: *bohono-letahaue* must be believed; *yaleno-letahaue* must be observed.

-so, -sota, -sote intensify the meaning of the transitive verbal base to which they are appended and also form causative verbs: ituhusobi cho? did you really bewitch?

-manta means to desire, wish for; incorporated into verbs it forms *desiderativa.*

Full paradigms of the verb cannot be given yet, but such elements of verbal conjugation which seem to be recurring in most verbs, are, when applied to the verb *mo,* to speak:

ni mola I speak.
chi mo thou speakest.
oque mo he, she speaks.
ocare moke they speak.
chi mobi thou didst speak.
momate speaking.

The particle or sign of the preterit is -bi-, -vi-.

Some personal pronouns used here are similar in form to the possessives, which are not prefixed, but constantly suffixed to nouns:

itina my father.
itaye thy father.
itimima his, her father.
itinica our father.
itayake your father.
itimitilama their father.

To this table must be added a variety of inclusive, exclusive and dual forms for the first person of the plural:

our father: itinicale, itinicano, itimile, heca itimile, heca itinica.

Adjectives, when used in an attributive and not in a predicative sense, are placed after the substantive which they qualify. The direct and the indirect object of the verb is very frequently placed at the head of the sentence.

Selected Texts.

To enable students of American languages to judge for themselves of the nature of Timucua, I insert a series of texts which I have taken from the most interesting parts, linguistically and ethnologically considered, of those writings of Pareja which I have had the good fortune to consult. To one series of questions I add the Spanish version of the original, to the others the English translation of the Spanish version.

For the old-fashioned, initial *y* of the Spanish and Timucua text I have substituted the *i*, to which it is equivalent.

Terms of kinship and genealogies.

Pareja gives several series of terms used in his time for *the pedigrees and castes* of the nobility and the people, which evidently are of totemic origin;

Digitized by Google

of terms for the degrees of *relationship* by consanguinity and by marriage, some of them used by men, others by women only, or by both sexes indiscriminately. The following is the most interesting of these pieces from a purely *linguistic* standpoint and I give it in the original Spanish. These terms were used by *both* sexes, as Pareja remarks.

(*From the first Catechism ; pages not numbered.*)

Los que son naturales, ó de una tierra, *Uti nocoromale.* Los que son de un pueblo *Hica nocoromale.* Los que son de una casa *Paha nocoronomale.* Somos de un pueblo *Hica niahobale,* ó: Somos de una casa todos *Hica nicorobale, paha niocoralebale.* Somos de un linaje, ó casta, ó generacion *Anoquela niyahobale.* Sois de un linaje, ó generacion, ó estirpe *Anoquela chiyahobale.* Son de un linaje, ó casta, ó generacion *Anoquela yahomale.* De que linaje eres? *Anoquela chichaque ne?* Quienes son tus parientes, ó parientas? *ano chichaquene chitaco chiano mi?* ó: *chitaco anoya?* Parientes y parientas, y hermanos y hermanas se dizen entre si: *Ano virona,* ó: *elapachana.* Hermanos, hermanas, parientes y parientas se dizen *Anoniamale,* ó: *elapachamale*; *Elapacha* es: comun parentesco: y estos tambien son comunes: *Anomalema,* ó: *ano oquomi,* ó: *ano oquo malema.* Viudo, viuda: *ubua,* llamado por *sus* parientes ó parientas solamente.

Todos los que descienden de los linajes que se tienen por parientes se llaman todos estos descendientes, *ocorotasiqino.* Pero todos los que descienden de un linaje, y parentela, se llaman *siqita pahana.* Y esta descendencia ha de ser por linea de varon; por que si es por linea de muger, se llaman *anoquelama* ó *Anona;* parentesco de lejos *ucucanimi.* Amo, señor y basallo, esclavo; y amo y esclava; y amo y criado y criada: *Anocomalema,* Amo y criado, y amo y basallo: *Anoquelamalema* ó: *anopequatamale.* Señor y esclavo; y esclava y esclavo; y esclava y señor: *Atemalema.* De modo que si se pone primero el amo diremos: amo y criado, y si se pone el criado antes quera dezir criado y amo, y assi de todos los demas que quedan dichos, y se hallaren de estos generos.

On the nativity of Christ.

Doctr. Christ. p. 24.

Para que mas se hizo hombre?	Acuyano hachaquenenco bueta caqua taanolebi?
Para que mas se hizo hombre?	Acuyano hachaquene caqua taanolebi?
Pues para que se hizo Dios hombre?	Hachaqueniqe Diosimano caque taanolebi?
Como puede nacer de Madre Virgen?	Isomima aquitasiqe lenima hachaquentana aruquilehe?
Sobrenatural y milagrosamente.	Inino lebima tana inibitileta hiquo timonococoleta hachiti moponta siqitantela ha.
Y su Madre, Sancta Maria, vivió	Mine isomimano, Santa Maria mu-

Digitized by Google

despues siempre Virgen? — enoma, etabualunimate nanemi aquisatique cumenu yaqualebi?

Si, perpetuamente fue Virgen. — O, nanemi aquita cumenu yaqua hibuabila.

The following interrogatories mainly refer to the SUPERSTITIONS, *vices* and *heathen practices* of the natives, whom the Spanish priests had come to reform and civilize: they are of uncommon interest to the investigator of American ethnology.

Questions addressed to Chiefs and Governors.

(Confessionario, pages 127, 128, 129.)

When intending to join a hunting party, did you order prayers to be said over the tobacco beforehand? — Emiso haueleta hinino ituhusobi cho?

On arriving on the mountain, did you order to lay the arrows together and let the conjuror say prayers over them for your benefit? — Hurima minonomano atuluma horocoqe naribama ituhuaue mobi cho?

Did you say that the first deer killed should belong to the conjuror? — Honoso nihe qibema itufama honomi-lehauele mobi cho?

Did you order that over the lake prayers should be recited before fishing in it? — Camapatama hibinoma ituhu chicaqe quelano-lehaue mobi cho?

In the same manner, did you order that of the fish caught for the purpose of eating, the conjuror should get one-half, after having prayed over them? — Acuqueleta hiquinomano ituhusota cuyumono itufama isaqita ohonolehaue mobi cho?

The first fish caught did you order prayers to be said over it and then to throw it into the provision-house (barbacoa)? — Cuyupona qibema inti uquata ituhuta oquono-lehauele mobi cho?

Did you before tilling the field recite the ancient ceremony to the conjuror? — Pile pulunu-lehauema ituhusuta hibuata bechata pulubi cho?

Did you [think it sinful not to] pray over the first maize of the crop? — Tapolabaca qibema ituhusuta hebi cho?

The first time when the corn-crib was opened, did you make any flour for food? and after pounding flour did you pray over it? — Abopaha falino qibema ipita huyosota ituhutaqere hebi cho?

In gathering chestnuts and palmetto berries, did you perform with the laurel and while praying, the ceremony which had come out of use (que solia deshazer)? — Afataco si apuco quenema hebeta nali qui iribosota ituhusobi cho?

Digitized by Google

Did you say: "I shall not eat any mountain fruit, unless prayer be offered over it"?

Aya honoma ituhunuleqe hehanimanda hanibi cho?

Did you wish to eat any other fruit, over which prayers had been offered first?

Calamaqibe ituhunuleqe hehani manibi cho?

From these curious questions directed to the principal men of the tribe, it appears that one of the duties incumbent to a chief was the superintending of the ceremonies of incantation through the conjuror or prophet. Evidently these prayers and ceremonies were intended to consecrate natural objects, which formerly had been profane, for men's use, and at the same time to propitiate the Divinity in favor of those using them.

Questions directed to Rural Laborers.

(Confessionario, page 129 recto).

Did you not eat the first maize of the crop?

Hulubota qibinoma inti uquabi cho?

Did you not eat the maize of the newly broken field (de la roça nueva)?

Abara elema ecano qibema inti uquabi cho?

When the owl was crying did you believe that it would have mercy on you?

Hitiqirima hebuataqe hoba nimelabonihaue mota bohota mosobi cho?

When the woodpeckers sang, did you say you would not utter any cry, because it would cause you to bleed from the nose?

Tiniboma hebuataqe iquasetiquanichinima isitocobile bohota mocobi cho?

When the owl or red owl was crying, did you say: "Do not interrupt it, for it would cause you mischief?"

Atofa hororoquene hebataqe nanibeti, queni intila mobi cho?

In winter time did you [think it sinful to] eat the small partridge (la gallina pequeña)?

Caya-ule-i chira na minama inti uquabicho? (words in [ ] not in Timucua text).

Questions to Hunters.

(Confessionario, page 129).

When a [young] deer was bleating, did you say: "If I do not take any herbs into my nostrils they will be shaken up," and if in this thought you have sneezed and returned home, did you bathe in the juice of the herb? and have you believed that when omitting this you would certainly die?

Honoso hebasi, habeleta itorita chininipe lotahaue manda, niyefela tasamota niyena haquista, paha pononomate samota quosobi cho? nocomi nini habela manda bohobi cho?

Digitized by Google

Did you say or perform any ceremonies for the chase by kicking with the feet (armando la coz), and did you stop eating of the game which you had killed, believing that you would then kill no further game?

Uquestanaye, hachicaresta isota mosobi cho, honoso ilifotanaye, intiquáta hehanano ni ilifohaueti manta bohota mosobi cho?

Did you forbid that the liver and lungs of the game should be thrown in cold water to cook them, because you could then shoot no further game?

Chofama pilenoma ibine ichicosa ecatiquani ilifoqi tinibalusihabele mota mosobi cho?

Having pierced the game with arrows without killing it, did you order prayers to be said over an arrow, believing that with the next shot the game would die?

Baliteque atulu nalifochiqe, nihetileqe, atuluma ituhusota niyena mocosota, naipolotecata mosobi cho?

The sauce (caldo) of the game or of the partridge, did you prevent its spilling because the lasso would not catch then any more of them?

Neha ichuquininoleqe honosomate, cayamate quenequa uquesinoma uba hauetila manda bohobi cho?

(Skipping a few questions on page 130 r. and verso on account of their great length, I continue with page 131 recto).

Did you forbid going up to the corn-crib, unless prayers had been offered for it to the Spirit?

Anomisonoma ituhutetima abopahama iquinole-hamonta inti uquata bohota mobi cho?

For seeking the turtle and catching it did you pray?

Caramaba pilisota hiti hebuanoma ituhuta quosobi cho?

In passing with the canoe a rock ledge (barra ó vaya) and there being a surging of the sea, did you whistle at it for not getting upset?

Ibi abagalata nayeno ticoma piluabe tileqe ibinaqe elota piluhauetila manda bohota elofibi cho?

Did you whistle (or hiss) to the storm, thinking that it would cease then?

Aqetuqe elotequahaniso hale manda bohota elosibi cho?

When you find yourself in similar distress, call the holy Name of Jesus, and Jesus will help you.

Naquentaqe entahanaye Jesus motabisato tachiqe chi ibalu hauele chilarahaue quenela.

Superstitions concerning warfare.

(Confessionario, page 131 r. and v.)

When it was lightening did you forecast war?

Milicotaqe iri nabolotele manda bohota mosobi cho?

When going to war did you bathe yourself in the juice of certain herbs?

Irimi haueleta atulu ni iubue hau ele niye suquoniqi mobi cho?

[Know well, my son,] that although you bathe in or rub yourself

Naquostaniye, samota monocotacu Diosima manininco nacu atulu

Digitized by Google

with this weed, the arrow will nevertheless transfix you if God does not guard you.

chi iubehe yanacu maha suquonina ticotacu Diosi manineco nacu atulu chi yubeheti quenela.

Questions addressed to women.

(Confessionario, page 132 v. 133 r.)

Did you eat any fish or deer-meat during the catamenia?

Ibirita cuyumate honoso henomate quene inti uquabi cho?

A short time after confinement did you eat fish or such things?

Eta baluta cuyuleqe hachibueno eyoleqe quenema inti uquabi cho?

Shortly after the confinement did you make a new fire (candela)? Did you make any during the catamenia?

Eta baluta taca chale quosobi cho? Ibirita taca chale cosobi cho?

Anointing your own hair with bears' grease (azeye de oso) did you think it sinful to eat fish for so and so many moons?

Ara uque naponaye cuyuhanta acuhiba meteta minoqe henolebinco. hehanimota mosobi cho?

Did you eat any coal, dirt, or broken pottery, or fleas or lice?

Tacachuleheco, qisaleheco, ulipassaleheco quenehata, ibiqitaleheco, hibeleco quenema iparubi cho?

[Do not eat coal nor dirt nor fragments of pottery, for] they make the person sick, and it is sinful on account of the injury produced.

Nacare henomano inti lehe caqua atenaso, ninoleqe, ano iqilabosobiqe hecaqua atenasoninoma intele hani hache.

After your husband had left you, did you bathe in the juice of herbs, thinking that he would then return to you?

Inifaye chi haniqe viromaqua niponosihero manda, niye nisamosono-lehaue mota bohobi cho?

Did you say: tinge ye my palm-leaf hat with a certain herb (saumad me el guano con cierta yerba) and he will not desert me?

Canima niye ni naquila sinoleqe utihanle mota bohobi cho?

And having tinged it, did you put on your petticoat?

Cani meleninoma niye naquilanolequemeleniqi mobi cho?

Did you think that in tinging your hat in that intention somebody would get enamored of you (se aficionará)?

Cani abinoma niye namocosonoleqe abiqiti anoco ni homanisihaue manda bohota quosobi cho?

Did you fast in this intention?

Na quostanayeno itoribi cho?

And thus you arrived with somebody almost at night time and you performed the ceremony as if for eating and drinking?

Itoritequa ilaqiqe henomate peleta, ibinemate peleta quosobi cho?

I do not pretend to have written all the words of these sentences and of the vocabulary, following hereafter, in a strictly correct manner, but cer-

Digitized by Google

tainly more correctly than they are found in the original. A good orthography cannot be established before the idiom is thoroughly understood.

In studying and analyzing the words of Timucua, the same idea obtruded itself to me, which occurs so often to students of the South African and of some Western American languages: "*Are not all the words, even their radical syllables, built up of pronominal roots?*"

Words and Sentences.

I have placed here in alphabetical order some of the vocables, the meaning of which I have ascertained through careful comparisons of the passages in which they occur. Some of the words which I have mentioned in the grammatical notices, the numerals, f. i., I have omitted in this table.

abo maize, corn-plant.

abopaha corn-crib, Span. garita.

aboto stick, staff; to beat with a stick: anoco abotobi cho? did you beat somebody?

acu all, every; acu caki all this, acu kelata in the same manner, exactly so.

afata chestnut; afataco hebeta for gathering chestnuts.

aha acorn.

apu grape of palmetto, palmetto-berries.

aquita maid, aquitasiqe virgin, damsel.

ara bear; ara-hasomi those forming the Bear-Pedigree.

aruqui child, descendant.

cuyu-hasomi aroki descendants of the Fish-Pedigree or family of fish; aruqui-lehe he was born.

atofa owl.

atulu arrow.

balu, valu life; balu nenemi eternal life.

eta baluta after a (recent) confinement.

bohono to believe.

caya chicken, partridge, turkey.

camapata to fish; c. ibinoma to fish in the lake or lagoon.

coro the same; uti nocoromale those belonging to the same country.

cuyu fish.

chebe to lose; hachibueno chebeque, h. chebuamano something lost.

chini nose, nostrils.

chiri small, young. chirico viro boy, son (lit. little man, young man) chirico nia daughter, both used only by their parents; chirima, amita chirico my youngest daughter. Related to *chale* new.

chofa liver.

chuca? how many times? (from cha, hacha? who? what? which?)

eke, equela day.

hasomi lineage, pedigree.

caya-hasomi chicken-pedigree.

ara-hasomi Bears' lineage.

Digitized by Google

hebua, **hebuata** word, saying; to speak, to emit voice,—**hebuataque tiniboma** the woodpeckers sing (see: honoso).
nurabuote a lie.

heno to eat; **henomate ibinemate** for eating and for drinking, **chucaya haheno?** how often did you eat? **hehani manibi cho?** did you wish to eat?

hibe louse.

hica settlement, town, village; appears in Tarahica and some other local names mentioned above.
hica nocoromale the citizens of the same town.

hiyaraba American lion.

holaba (also: **tapolaba**) maize, Indian corn; **holabaca qibema ituhubi cho?** did you pray over the first-grown maize?

holata chief, **holata aco, olata ico**: all chiefs.

honoso deer, antelope; **honoso hebasi** when the deer is bleating.

huta to cohabit; **niaco hutabi cho?** did you cohabit with a woman?

ibine water; pond, lake, sheet of water.
hibita river.
ibinese to bathe.
inibiti (see below).
hibua to rain. **hibuabi cho?** have you produced rain? did you cause it to rain?
banino rainbow.
ibirita to menstruate.
mucu-bine tears (lit. eye-water).

icasini to altercate, quarrel; **anoco icasinibi cho?** did you quarrel with some one?

ikeni to kill (probably a contraction from: **ike nihi**, to make die); **anoco ikenibi cho?** have you killed anybody?

inibitisote to drink to excess, to fill oneself with liquor; see ibine.

inihi consort, husband *or* wife. **inihimale** married couple.

iri war, warfare, **irimi haueleta** for going to war; **iri-hibano** war-councillor; this caste were descendants of the Fish-family.
urri-paracusi war-prince.

isa mother.

isu, **isota** herb, weed; a plant, the juice of which was used for superstitious purposes. **Nie chaqueneco isota** with which herb?
isucu, herb-doctor.
isucu echa crazed, possessed by a demon.

iti father; **itimileno** "our father": spiritual father, monk, priest.

itori late, posterior.
itorimitono the last order of the second pedigree of Timucua nobility.
itori to fast; **equelaco maha itorinoma** the days of fasting.

ituhu to pray, conjure, invoke, charm, bewitch; **ituhusobi cho?** did you conjure or bewitch? did you say prayers over something?
itufa sorcerer, wizard, medicine-man.

Digitized by Google

ya, aya not, no; in *yalacota* misuse, abuse it has the meaning of our prefix: *mis-*

kala fruit; calama kibe the first fruits.

kenele afterwards, subsequently, then.

kibe first; adv. firstly, at first.

tapolabaca qibema the first maize of the crop; hulubuta qibinoma the first maize. qibe ituhumuleqe over which a prayer has first been recited.

kie child (used by men); kiena moso my first son, my first daughter. kiani cocoma my children of later birth. kimale son *and* father.

kisa earth, ground, dirt. qisa iparabui cho? did you eat dirt?

koso to make, produce; taca chale cosobi cho? did you make a new coal-fire?

lapuste, lapueste to require, ask for.

mani to agree, consent; anoco nihihero manibi cho? have you wished somebody's death?

manta to desire, wish; ni mantela I wish, chi mante you wish.

mine prior, preceding, first; large, great. miso anteceding, older, previous; ulena miso my child of first birth, eldest child (used by females only).

mo to say, speak; to order, command. movi cho? mobi cho? hast thou ordered, or said? mote cho? do you consent? do you say so? o, motala! yes, I say so!

mueno, mono name, to name.

muenolete Diosima? is he called God?

hachimueno, hachabueno which thing? thing, object.

visamano name.

na kostanaye? in which manner? through which process? na quostanayeno by what intention?

nayo white; honoso nayo white deer.

nanemi perpetual, eternal; adv. always; balunu nanemi nohohauela to give me eternal life.

nasi son-in-law.

nariba old (of persons). naribama ituhuaue mobi cho? did you order the old sorcerer to say his prayers?

nia woman, female (see pacano).

nihi to die, expire; honoso nihe qibema the first deer killed.

nocomi true; nocomicoco manda with true desire; Dios nocomi bohonoacoma to believe truly in God.

nulasi to tickle.

o yes, yea, certainly.

obacha to kiss.

orobo to advise? orobinibi cho? did you confess (in Church)? anoco orobasobi cho? did you bewitch some one? na orobisionoma advices, counsels.

pacano subsequent, second to.

Digitized by Google

nia pacano a spinster; pacanoka my second child (hijo, hija de en medio). viro pacano unmarried man.

pequata vassal.

pona to come; ni ponala I come.

ponachica? do you bring? (see: viro).

soba meat; deer-meat.

taca fire; coal-fire; taca chale new coal-fire (candela nueva in Span.); taca chu carbon, charcoal.

tafi sister-in-law (used by men only); tafimitana, ni tafimitama the brother of my husband (used by women).

tico canoe, boat; ticopaha ship.

tinibo woodpecker.

ulipassa fragments of pottery (uli = Span. olla).

uti earth, land, country; uti-hasomi those forming the Earth-pedigree or Earth-Family, utina my country; uti nocoromale the inhabitants of ONE country.

viro man; chiri viro boy, son; viroleqe uquata puenonicala, I brought here a male child.

The Approaches to a Theory of the Cause of Magnetic Declination.

By Persifor Frazer, Jr.

(*Read before the American Philosophical Society, April* 6, 1877.)

So many questions of historical, economical and scientific interest are bound up with the variation of the magnetic needle from the astronomical North, and the change in the rate and sign of this variation, that the following remarks may be excused, even if they only succeed in impressing upon the imagination the immense amount of work which yet remains to be done. The best compendium of the history of the subject is contained in a prize essay on Terrestrial and Cosmical Magnetism by E. Walker, Cambridge (Eng.), 1866, while for particular discussions of special groups of observations, Sabine's Secular Variations of the Magnetic Needle, in the Trans. of the Royal Society during the last five years; Prof. A. D. Bache's discussion of the magnetic elements, observed at Girard College during the years 1840–45 inclusive; in Coast Survey Reports for for 1855, 1858, 1859, 1860 and 1862, and especially Mr. C. A. Schott's labors on these and all other obtainable data in the United States, have been mainly drawn upon. Besides these, for general questions relating to the subject, Barlow's treatise in the Encyclopædia Metropolitana; Airy's treatise on Magnetism, London, 1870; Numerical Relations of Gravity and Magnetism, by P. E. Chase, Trans. A. P. S. 1864; Prof. Loomis' collection of magnetic observations; Silliman's Journal, 1838 to 1840; Reclus, Despretz, Becquerel, Humboldt, "Magnetism," by Sir W.

Digitized by Google

S. Harris and H. M. Noad, and "Diurnal Variations of Declination," by Wm. Norton, have been consulted.

A large number of observations with their authorities will be found at the end of the Report of C. A. Schott in C. S. Report for 1858.

Resumé from Coast Survey Reports.

In the C. S. Report for 1855, p. 302, is a chapter by Prof. A. D. Bache, on the Magnetic Declination in the northern part of the Gulf of Mexico. The observed declinations are reduced to the common date of Jan. 1850, by an assumed annual decrease of 0′.5 E. declination from observations made at Pascagoula in 1847 and 1855.

The equation representing the true declination with reference to the latitude L and the longitude M of any place, here follows :

$$dV = v + x\,dL + y\,dM + z\,dL\,dM + p\,dL^2 + q\,dM^2$$

dV = difference between the observed decl. and the assumed decl. V'

V = correction to the assumed V'.

The solution of the conditional equation, for any latitude L and longitude M gives the following expression for V :

$$dL = L - 28^\circ.04. \quad dM = M - 88^\circ.69.$$

$$V = 7^\circ.39 \text{ East} - 0.025\ dL + 0.296\ dM + 0.0188\ dL\ dM - 0.0094\ dL^2 - 0.0076\ d\,M^2.$$

All the declinations being East are treated as essentially positive quantities.

The number of groups of stations selected was six, in order to solve the six unknown quantities in the first equation.

There were the following number of stations in each group. The Roman numeral indicates the number of the group, and the Arabic numeral the number of stations : I, 1 ; II, 1 ; III, 4 ; IV, 4 ; V, 3 ; VI, 1.

The average of the residual—(*i. e.* the difference between the observed and computed declinations)—was 0° 056 = 3′.3.

For the observations in the general table, the form of the conditional equation is the same as above.

$$V = V' + v + x\,X + y\,Y + z\,X\,Y + p\,X^2 + q\,Y^2.$$

The annual variations were an estimated approximation by mutual comparison of the known values at Toronto and on the Atlantic coast.

The origin of co-ordinates is assumed midway between lat. 43° 26′, long. 70° 24′; and lat. 29° 07′, long. 83° 03′; the co-ordinates of position are expressed in degrees and decimals and *were graphically obtained* by caretul plotting on a large scale.

Mr. Chas. A. Schott in the same volume furnishes a discussion of the magnetic declination on the Atlantic and part of the Gulf coast (communication to the American Association for the Advancement of Science, Appendix 48 to Coast Survey Report for 1855,) of which the following are some of the points :

Hausteen's publication "Investigations of the secular variation since the magnetic observations in Coast Survey Report of 1854," gave a new impulse to these investigations.

Digitized by Google

Dr. Bowditch and Prof. Loomis were mainly instrumental in bringing this subject prominently to the notice of scientific men.

Prof. Loomis gives (Silliman's Journ. of Sci. and Arts 1840) the annual change of variation in 1840 as 2′ *for the Southern States*, 4′ *for the Middle and* 6′ *for the New England States.*

The essay is divided into: (a) Stations of reliable observations prior to 1740; (b) Ditto after that time; (c) Results from comparatively recent observations; (d) Establishment of formulæ expressing the secular variation within the limits indicated on the title page (*i. e.* the Atlantic and part of the Gulf coast).

Under (a), Providence, R. I., Hatboro', and Philadelphia, Penna., are selected. Thirty declinations collected by Mr. M. B. Lockwood from actual observations and recorded bearings of a number of objects, are considered. The formula employed is

$$D = d_0 + y\,(t - t_0) + z\,(t - t_0)^2 + u\,(t - t_0)^3 + \&c.$$

Where y, z, u are unknown coefficients, and $D = d$ where $t = t_0$. Putting $d_0 = d_{\prime} + x$ where x is a small correction to the assumed value of d, and omitting higher powers of the time, than the third

$$D = d_1 + x + y\,(t - t_0) + z\,(t - t_0)^2 + u\,(t - t_0)^3.$$

Assuming for t_0 the commencement of any year and for $d_{\prime}$ the supposed corresponding declination (expressed in degrees and decimals) then each observed value for D at the time t furnishes the following conditional equation: $0 = d_{\prime} - D + x + y\,(t - t_0) + z\,(t - t_0)^2 + u\,(t - t_0)^3$.

From this by the application of least squares the normal equations and coefficients of x, y, z, u, are obtained.

"The above formula is capable of giving two maxima and two minima, whereas the omission of the third power would give but a minimum. *And this as we know from observation took place about the commencement of this century.* t_0 is assumed as 1830;* and $d_{\prime} = +\ 7.20$."

A table of thirty observations in Providence, R. I., is reduced in size by substituting a table of sixteen means, which here follow:

1717	D = + 9.60	1790	D = + 6°.18
1720	9.47	1800	6 .25
1730	8.92	1810	6 .40
1740	8.28	1820	6 .66
1750	7.67	1830	7 .19
1760	6.99	1840	8 .42
1770	6.49	1842	8 .65
1780	6.27	1844–8	9 .25

Substituting in the above equations we have:

$$0 = -\ 2.40 + x - 113\ y + 12769\ z - 1442897\ u,$$

and similarly for the other fifteen equations.

Multiplying each of the sixteen equations by the coefficient of the first unknown quantity and adding them all up, we get the first of the normal equations, and the same operation performed for each unknown quantity will give the other normal equations.

* In the discussion of subsequent years this date was changed to 1850.

Digitized by Google

These would be as follows :

$0 = - 7.49 + 16\,x - 736.2\,y + 63832\,z - 5792927\,u$
$0 = + 573.26 - 736.2\,x + 63832\,y + 5792927\,z - 562891700\,u$
$0 = - 79077 + 63832\,x - 5792927\,y + 562891700\,z - 56610893300\,u$
$0 = + 8782402 - 5792927\,x - 562891700\,y - 56610893300\,z + 5831932000000\,u$

To facilitate reduction Mr. Schott assumes $x = X$, $y = Y : 10^2$, $z = Z : 10^4$, $u = U : 10^6$. Dividing the first equation by 10^0, the second by 10^2, the third by 10^4, and the fourth by 10^6, he obtains the modified normal equa tions.

$0 = - 7.4900 + 16.0000\,X - 7.3620\,Y + 6.3832\,Z - 5.7929\,U$
$0 = + 5.7326 - 7.3620\,X + 6.3832\,Y - 5.7929\,Z + 5.6289\,U$
$0 = - 7.9077 + 6.3832\,X - 5.7929\,Y + 5.6289\,Z - 5.6611\,U$
$0 = + 8.7824 - 5.7929\,X + 5.6289\,Y - 5.6611\,Z - 5.8319\,U$

Their solution gives

$X = + 0.239$ hence $x = + 0.239$
$Y = + 8.543$ $y = + 0.08543$
$Z = + 15.055$ $z = + 0.0015055$
$U = + 5.100$ $u = + 0.000005100$

and the formula for the declination becomes

$$D = + 7^\circ.439 + 0.08543\,(t - 1830) + 0.0015055\,(t - 1830)^2 + 0.000005100\,(t - 1830)^3.$$

A Table of Comparisons of the Observed and Computed Declinations at Providence here follows :

DATE.	OBSERVED.	COMPUTED.	Δ	Δ^2
	°	°	°	
1717	+9.60	+9.64	+0.04	0.0016
1720	9.47	9.46	—0.01	0.0001
1730*	8.92	8.85	—0.07	0.0049
1740	8.28	8.22	—0.05	0.0025
1750	7.67	7.62	+0.05	0.0025
1760	6.99	7.08	+0.09	0.0081
1770	6.49	6.63	+0.14	0.0196
1780	6.27	6.29	+0.02	0.0004
1790	6.18	6.10	—0.08	0.0064
1800	6.25	6.09	—0.16	0.0256
1810	6.40	6.29	—0.11	0.0121
1820	6.66	6.73	+0.07	0.0049
1830	7.19	7.44	+0.25	0.0625
1840	8.42	8.45	+0.03	0.0009
1842	8.65	8.69	+0.04	0.0016
1844–8	9.25	9.05	—0.20	0.0400

$$\epsilon_0 = 0.674\sqrt{\frac{\Sigma\,\Delta^2}{n-4}} = \pm\,0^\circ.085 = \pm\,5'.1$$

Mr. Schott proceeds to the establishment of formulæ expressing the sec

* A misprint makes this 1720 in Appendix No. 48, Coast Survey Report for 1855

Digitized by Google

ular variation in the rate of magnetic declination at any place within the limits of the stations named in the discussion.

By the tables thus framed the average error in the computed declinations is ± 0.0063.

He adds that the small table extracted from the Phil. Trans. Royal Soc. Vol. XI, abridged, from 1755 to 1763, which Hausteen used in the construction of the isogonic curves in his Erdmagnetismus, and which here follow are erroneous, inasmuch as we know that the Western declination had been decreasing from 1700 to about 1797, while the last two lines of this table make it seem to increase. It may be remarked that the first two lines virtually show increase of Westerly, because they show decrease of Easterly declination.

Observations by P. F. Jr.	Lat.	Long.	Declinations in 1700.	1730.	1744.	1756.
30 miles E. of Rodriguez Key, Fla.	25°	80°	$4\frac{3}{4}$ E.	—	$3\frac{1}{2}$ E.	3 E.
76 miles E. 8° N. of St. Augustine, Fla.	30°	80°	$2\frac{1}{2}$ E.	—	$\frac{3}{4}$ E.	0
32 miles E. S. E. of Cape Hatteras	35°	75°	$2\frac{1}{4}$ W.	—	$6\frac{1}{2}$ W.	7 W.
365 miles E. of Sandy Hook.	40°	70°	7 W.	9 W.	$11\frac{1}{2}$ W.	$12\frac{3}{4}$ W.

Mr. Schott's contribution to our knowledge concludes with the following remark :

"Before closing the appendix it will be seen that a look out for a time of inflexion to be expected about 1867 ± 15 years was not premature and indeed we find from the following comparison of the computed, and my last observed declinations that the latter always fall short of the former—a plain indication that the curve commenced turning its concave side towards the axis of abscissæ; or in other words that in 1855.5 the maximum annual increase had already been passed."

The annual variation of 1850 is recommended as a constant for some years till a new series clears up the point. He adds : * "Thus for example the declination in Boston in 1870 will be found by computing the increase for twenty years (the difference of 1870 and 1850) prior to 1850, and adding the same to the declination for 1880: the declination at Boston for 1870 becomes $+ 9°.81 + 1°.48 = 11° 18'$ W." †

Referring to Mr Schott's admirable *winnowed tables* to accompany the C. S. Report for 1874 we find the Declination at Boston for 1870 given at 10°.90 (see table of decennial values). This varies from his prophecy by 0°.28 or 16′.8 (or with the correction suggested below by 0°.39 or 23′.4).

* Written in 1855.

† Should this not be 11°.29 ?

Digitized by Google

He concludes by calling attention to the following epochs.

	Differences.
Deduced maximum declination in 1679 ± 10 years....................................	62 years.
Known first point of inflexion 1741 ± 10 years	57 years.
Known minimum declination 1798 ± 2 years	52 years.
Supposed second point of inflexion 1850.	

"From which it appears that the periods are diminishing or the velocity of the secular variation is increasing, which latter is sustained by a comparison of $V_{1741} = -4'.6$ with $V_{1850} = +6'.8$ or $+5'.9$," &c.

In Coast Survey Report for 1858 p. 192 to 197 Mr. Schott resumes the discussion of the subject. He announces the discovery at Hatboro, Pa. of a longer period of 234 years and a shorter one of 88 years, the range of the secondary motion being about $\frac{1}{15}$ of that of the primary or about $0^{\circ}.25$. The length of the shorter period as well as its epoch and range is different in different localities, but the fact of the existence of two such periods was afterwards confirmed by discussions of the periods at Burlington Vt. and Providence, R. I.

For the representation of the Hatboro observations the form was employed: $D = d + r \cos. (an + c) + r_1 \cos. (a, n + c_1)$ when n = number of years $\left.\begin{matrix} +\text{ after} \\ -\text{ before}\end{matrix}\right\}$ an assumed epoch; in this case the year 1830.

In the numerical application, the last term being neglected, the form adopted for the conditional equations was:

$0 = -D + d_1 + x + \cos. a\ n\ r \cos. c - \sin. a\ n\ r. \sin. c.$

The first assumption for d_1 was = 5.2 and $a = \frac{360}{250} = 1.44$ as pointed out in discussion of 1855.

In a second and third assumption (a) was varied. Afterwards that value was assumed which made the sum of the squares of existing differences a minimum. The probable ϵ_0 was $\pm 8'.6$ as against $\pm 11'.0$ in the former discussion.

The condition of the minimum declination is expressed by the formula $0 = 5.05 \sin. (1.54n + 46^{\circ}.8) - 0.90 \sin (4^{\circ}.1\ n - 13^{\circ})$ from which $n = -33.7$ years. Hence the minimum occured in 1796.3.

The effect of the last term is to place the minimum 3.3 years earlier. The former discussion (in 1855) placed the minimum at 1806.1 ± 19.3 years and the mean for all stations then discussed gave 1797.6 + 1.8 years.

By a first and second differentiation of the above formula v = +45.2 or *the maximum annual change will occur in* 1875.2.

From the observations since 1750, separately discussed in 1855 T = 1799.5.

From the next following discussion of the magnetic declination at Washington, it is concluded that the maximum declination at the close of the last century was $+0^{\circ}.42'$ or *the line of no variation* at its highest

Digitized by Google

ascent at that period *passed below Washington. It certainly passed above Norfolk.* *

The maximum declination will probably be $= 4^{\circ}.42$.

In Mr. Schott's discussion of the secular change in C. S. Report for 1859 he mentions that no entire cycle has yet been completed on either the East or West coast. The linear form of the formula first applied to all observations in 1855 (which does not involve any great length of period) is retained for the observations on the Western coast while a circular function is chosen for the others, of which the length of period and other numerical co-efficients have been obtained by the method of least squares. But he adds, "*as long as the cause producing the secular change remains altogether unknown* it is not safe to trust too far to the continuation of the law thus empirically derived."

He finds that "if the stations be arranged geographically, the minimun (West) declination occurred earlier at the Eastern than at the Western and Southern stations." * * * "*and if we proceed to the Western coast we find that the Eastern declination has not yet reached its maximum (equivalent to a Western minimum.)*"

This Report concludes with a record of all declination observations employed in the forgoing papers.

From the preceding imperfect memorandum of the analytical methods of some of the ablest mathematicians and magneticians, who have taken this subject in hand, and especially of those of Mr. Schott, it will be seen:

1st That to the best informed the cause of variation in declination remains still unknown.

2d The mathematical analysis proves the existence of a period including secondary periods, the latter resulting from perturbations due to some cause not identical with the main cause.

3d Over small areas and during short intervals of time the magnetic variation can be predicted and a formula established which shall express it.

4th The linear formula having shown the change of the *kind* of variation in abscissa after a certain epoch and in the *kind* of variation in the ordinate after another epoch establishes the cyclic curve as one of unequal axes.

5th. The easternmost North and South line which is tangent to this curve passes nearly through Washington and some distance west of Philadelphia. The westernmost North and South tangent is not yet determinable with exactness.

* By reference to the Isogonic chart previously mentioned, kindly corrected and sent me by Mr. Schott, March 17, 1876, the highest position attained by the Zero curve is marked in red ink as above Annapolis and Baltimore in 1795, while by computing the mean annual declination from the tables from Report of 1874 (Philadelphia) it will be found that the maximum was from 1740 to 1760 when it amounted to 10′.8, and the minimum from 1800 to 1810 when it amounted to 0′.0

The column for Washington only goes back to 1800 but its minimum seems to have been between 1790 and 1800. From this to the present time this annual mean for Washington presents several irregularities.

Digitized by Google

6th. The situation of this curve cannot be very near the Terrestrial Pole, since on the same parallel of latitude and with a distance apart of about 2,685 miles, Passamaquoddy Bay shows a (West) declination of + 18° and Salem, Oregon, an Easterly declination of — 20° for the same year. These curves unless forming abnormally acute cusps must meet if produced below lat. 70° as drawn in Col. Sabine's chart.

7th. It is probable that the location of the area of magnetic attraction is nearer to the Atlantic than to the Pacific, because the Isogonic curves of even degrees are nearer together in the former region than in the latter.

8th. Any theory which may be established to account for secular variation must accept the end of the last century or the beginning of this as one of the extremes.

9th. The total period of revolution according to the best data is about 237* years with a margin of a few years error more or less.

10th. The limits within which the declination for a particular date may be calculated for a station, where reliable observations are at hand, is about 8′ to 11′.

The following table was calculated to represent the magnetic variation at Mount Holly, Cumberland Co., Penna., for every five years since 1790, and may serve as an example of how such approximately accurate tables may be obtained for points where the records are very meagre.

In the first place the Isogonic chart of the Coast Survey for1870 (as corrected by the pen of Mr. Chas. A. Schott) was referred to for the positions of various isogonic curves which passed at different dates in the vicinity of Mount Holly. The exceedingly small scale of this chart and the uncertainty of the data from which many of the curves were traced, renders the attainment of the required declination only possible within rather wide limits, amounting perhaps to 20′ if all errors be taken into account; or a little more than the minimum (quarter of a degree) noticed by an ordinary surveyor.

Of course, if the chart be assumed as correct, the error is reduced to less than half this. The method employed for determining these declinations is as follows: After locating the position of the place whose declination is sought on the chart by latitude and longitude, a normal to the isogonic curves of the date required is drawn through this place. The distance apart on this line of the nearest curves of whole degrees between which the place lies, is accurately measured, and afterwards the distance from the point to that one of these curves which is represented by the smallest number of degrees. This distance in the same units multiplied by sixty and divided by the former number will give the number of minutes, which being added to the smallest number of degrees represented by the two curves, furnishes the correct declination of the place at the date for which the curves are drawn. If any actual observations of the declination at the desired locality are at hand these may be compared with the nearest place at which observations have been carried on, and the annual rate of change of the

* See Mr. Schott's Report, *ante*.

Digitized by Google

amount expressing the difference between the two declinations calculated and noted for each term of years between such data. When observations are entirely wanting, an approximation to the true declination may be made in the manner already described; though the accuracy of such a method will be inversely proportional to the distance along the isogonic normals to old stations of record, and directly as the distance apart of adjacent curves.

Date.	Declination at Philadelphia.	Declination at Mount Holly.	Difference.	Remarks.
1790	West + 2° 24′	West + 0° 14′.54	2° 09′.416	
1795	" 2° 15′	" 0° 5′.17	2° 09′.832	
1800	" 2° 06′	East — 0° 04′.24	2° 10′.248	
1805	" 2° 06′	0° 04′.6	2° 10′.664	
1810	" 2° 06′	0° 05′	2° 11′.08	
1815	" 2° 11′.5[a]	0° 0′ [b]	2° 11′.5	* Subtract 0′.416
1820	" 2° 17′	West + 0° 05′.92	2° 11′.08*	from each differ-
1825	" 2° 29′.5	" 0° 18′.84	2° 10′.66	ence to obtain the
1830	" 2° 42′	" 0° 31′.75	2° 10′.248	next following
1835	" 3° 0′	" 0° 51′.17	2° 09′.832	down to 1845.
1840	" 3° 19′	" 1° 09′.5	2° 09′.416	
1845	" 3° 46′ [a]	" 1° 37′ [b]	2° 09′ †	
1850	" 4° 07′	" 1° 49′.88	2° 17′.12	† Add 1′.625 to
1855	" 4° 33′	" 2° 07′.76	2° 25′.24	each difference to
1860	" 4° 59′	" 2° 26′.62	2° 33′.37	get the difference
1865	" 5° 26′.5	" 2° 45′	2° 41′.5	for the succeeding
1870	" 5° 54′	" 3° 04′.38	2° 49′.62	year.
1875	" 6° 20′	" 3° 22′.25	2° 57′.75	
1877	" 6° 30′[a]	" 3° 29′ [c]	3° 01′	
1880	" 6° 46′	" 3° 40′.12	3° 05′.875	

a. Interpolation from Assistant Schott's tables of decennial values of magnetic variation, U. S. Coast Survey Report for 1874.

b. From chart of Isogonic lines 1870. The positions of the curves with respect to Mount Holly were measured from additions in pen by Mr. Schott.

c. Observation by Beaton Smith.

Digitized by Google

Regarding some Mesozoic Ores.

By Persifor Frazer, Jr.

(*Read before the American Philosophical Society, April* 20, 1877.)

There are several places in the New Red Sandstone where, although the presence of no other formation within several miles is intimated on the old map, nor has any sudden change of character in the rock been suspected, there nevertheless appear to be good reasons for supposing that the outer shell of the Mesozoic strata has been worn through and the underlying and older formation has been exposed. One instance (of not much weight, owing to its very local character and its proximity to the actual boundary between the two formations) occurs near Franklintown, York County, near Lerew's tavern, where an oval piece of ground seems to be composed entirely of the older schists, while the contiguous country is made up of the newer shales and sandstones.

The same thing may be noticed near Bendersville and near Arendtsville, where small islands of Mesozoic seem to stand out in a sea of Huronian schists and débris. Many such instances taken from other formations will occur to every geologist, and a glance at the State geological map of the last survey will convey the same fact forcibly through the eye to the mind; for there it will be seen that not only are the bounding edges of the formations ragged, and the shreds of one left within the domains of tl e other, but (sometimes on account of the geographical and orographical conditions under which the original deposition of beds took place; and sometimes owing to the peculiar action of erosion) great peninsulas, islands and archipelagos, are to be seen distinguishing themselves from the formation in which they lie by the colors chosen by Prof. Rogers to represent them.

Such, for instance, are the strips of what Prof. Rogers called Primal and altered Primal which stretch out like an Aleutian chain in the limestone sea of Lancaster and York Counties.

So far as this occurrence of the Huronian rocks within the limits of the New Red Sandstone is concerned, it is important in more ways than one.

1st. As accounting for the presence in the newer of many constituents characteristic of the older rocks in other parts of the country (magnetite, copper ore, etc.); and 2d, in resolving the doubt as to the comparative thickness of the New Red Sandstones at adjacent points.

It has long ago been suggested that the presence of the iron "Glances" in the red shales and sandstones, and the presence in the latter of more or less well defined belts of copper ore, might be accounted for on the supposition that in the making of the newer beds the older were ground up and redistributed (*re-sedimented* would better express the idea).

We know as a fact, adverted to elsewhere, that the only horizons in which copper ores have been found in this State are the South Mountain series of crystalline schists, etc., and these very rocks in question. And even if we seek elsewhere in this country, except a very limited deposit in the Medina

Digitized by Google

group, and the lean copper shales of the Catskill, none but still more insignificant exhibitions have been noted in other formations.

It might be easier to account for cupriferous shales and sandrocks in the Triassic beds were we sure that ferriferous and cupriferous Huronian rocks were actually in contact with their lower surface, and provided also we could find evidences of such cupriferous and ferriferous horizons among the rocks of the South Mountain system, which are evident lateral continuations of the bed of the Mesozoic sea.

It is true that a copper horizon has been noted in the Orthofelsite of the South Mountain, as at Watson's, Snyder's, etc. in Adams County near Monterey; and deposits of Micaceous and Specular Iron Ore of very great beauty at G. Coles' near the summit of the Gettysburg-Chambersburg turnpike (both of these in the Huronian series): and also that many minor occurrences of specular and magnetic iron ore disseminated through the rock in minute crystals (as in specimens found on Green Ridge near Caledonia Springs, etc.); but all the deposits thus far discovered will not account for the exceptionally rich character of that portion of the Mesozoic beds which abuts upon the eastern flank of the South Mountain.*

In my report of progress for 1875 (Second Geol. Survey of Penn. CC, p. 328), I have given reasons for the rejection of any theory which implies a local deposit of these ores (*i. e.* only along the borders of the formation), and I have cited eleven localities scattered over the length and breadth of the Mesozoic belt in York and Adams Counties where micaceous ore appears—more or less mixed with magnetite. The copper horizon of Phœnixville seems at first sight to agree well with the views advanced by Dr. Hunt and others concerning the restriction of the metalliferous strata to the two edges of the New Red, for Phœnixville lies very near the southern edge of this formation on the Schuylkill, where it has dwindled down

* Dr. T. Sterry Hunt, in a recently published paper on the "Cornwall Iron Mine and some related deposits in Pennsylvania," states as follows:

"But I have now to bring to your notice" * * * "those ores which are found "over Pennsylvania along both borders of the Mesozoic red sandstone forma- "tion which stretches through the State; including on the south side the ores "of Warwick and the Jones Mine, and on the north side a line of deposits from "Boyertown and the vicinity of Reading to beyond the Susquehanna, includ- "ing the great Cornwall Mine near Lebanon."

"These ores were by Prof. Rogers referred to what he designates the Primal "slates, which he regarded as the lowest member of the Palæozoic series, though "by some later observers the Cornwall Mine and certain related deposits west "of the Susquehanna have been referred to the Mesozoic sandstone. It would "be foreign to my present purpose to set forth the reasons which lead me to "conclude that these are, all of them, really contemporaneous deposits included "in the Primal slates, which corresponds to a portion of the lower Taconic se- "ries of Emmons, and belong, in my opinion, to a lower horizon than the "Potsdam sandstone of the New York system. *That they are met with only along "the borders of the Mesozoic sandstone formation is due to the fact that those ancient "ore-bearing rocks, from their decayed condition and their inferior hardness, have "been removed by denudation, except when protected by the proximity of the newer "sandstones or of eruptive rocks, as is the case at the Cornwall Mine.*"

(Transactions American Institute of Mining Engineers, Vol. IV, p. 320.)

Digitized by Google

to about half the breadth which it exhibits on the Delaware. It is worthy of note that this contraction of the area of the New Red has been brought about by a sloping inwards towards the median line of both its north and south boundaries, so that if the breadth of the Mesozoic rocks on the Delaware were continued to the Maryland line, this ore region would fall but little below the axis of the belt. Furthermore, this position would accord well with that of the copper ore deposit in Bonnaughtown, about eight kilometers (or five miles) east of Gettysburg.

The same argument may be applied to the iron ores of the Altland mines, which are cut in specular, somewhat magnetic and very cupriferous ore, for this locality lies 11 kilometers (or 6⅘ miles) S. E. of the N. W. limit of the New Red.

If the same view be held to explain the Cornwall deposit and the Altland deposit the latter must be of ante-Potsdam age. This, however, is not at all yet sustained by observation.

Again, if the source of all this magnetic-micaceous ore be assumed to be the older slates, then it seems to indicate that the greater part of the sand obtained by wearing the shores of the Mesozoic sea was obtained from the Huronian rocks, for over every kilometer (⅝ mile) of the breadth of the deposit in York and Adams will be found *some* flaky "iron-glimmer," besides many belts of shale and sandstone, colored green with the débris of the Huronian chlorites and sparkling with the hydro-micas of the same age.

Now supposing that this were true, *i. e.* that either the greater part of the Mesozoic sandstone rocks, or at least a large proportion of them, taken in any part of the belt, consisted of the débris of the Huronian schists worked over, it might prove a connection between these ore deposits, but a few miles from the South Mountain, and those of the latter: independently of whether the shallow but monoclinal structure of these beds (as explained by the wave strewing hypothesis of H. D. Rogers; or the deepening trough-bottom hypothesis of J. D. Dana),* or the normal deposition, folding and subsequent erosion shall be assumed, for even in this latter case a margin of a certain width along the coast line, where the water was shallow, would show in the deposits the characters of the original rock forming its shelving bottom.

So that in any case we should look for the Huronian source under the present position of the ore, because the waves which broke up the shallow bottom would strew the débris in the immediate vicinity of the parent rock.

[In Rogers' hypothesis the direction of the apparent motion of the wave is the really important factor, and it is difficult to understand why we should not have S. E. dips on the S. E. margin of the Mesozoic estuary, since the waves are supposed to produce layers dipping in shore. (See diagram, Vol. II, Part II, p. 812, Final Report on the Geology of Pennsylvania.)† Or vice versa if the *suspension* hypothesis (ibid, diagram p. 813) be preferred.]

But, abandoning this wave-strewing hypothesis as altogether inadequate

* Manual of Geology, 1875, p. 421. † 1858.

Digitized by Google

to account for beds of such depth as those we find in the New Red, we may nevertheless consider the effect of the waves in forming strata of sediment in the shallow portions adjacent to the coast (which here seems to have been the South Mountain).

The direction of the line of Section 7, Report for 1875 C C (which corresponds with the South Mountain portion of the Section of the same number in Roger's final Report) was chosen, after an examination of the plotted work in that region permitted a mean of all the mountain dips to be taken. The direction of this mean dip was chosen as the direction of the section line because it was the line most nearly corresponding with all the observed dips. A direction perpendicular to this will therefore represent with the nearest approach to exactness the strike of the old Huronian rock.

These mean dip and strike lines are constant for the entire portion of the South Mountain here under consideration.

This strike is E. 27° N.

The strike of the New Red Sandstone rocks contiguous to the above Huronian rocks was calculated in the same way, for Section 6a (the nearest Section) and is E. 40° N.

These lines thus intersect each other at an angle of 13°.

If we assume that all the New Red Sandstone rocks which cover a strip of country from 10 to 12 kilometers ($6\frac{1}{4}$ to $7\frac{1}{2}$ miles) from the base of the South Mountain were parts of the shallow or littoral Mesozoic sea, and therefore especially subjected to the wasting action of the waves; it is natural that the ore belt of the new forming rocks must follow approximately the ore line below, and since only in a limited margin beyond the actual breadth of the parent bed is it likely that the ore would show in the new formation, it might appear as if deposited in a vein more or less clearly defined, and following a course of about E. 27° N. It should be here emphasized that this might be so independently of the accuracy or error of the wave-strewing hypothesis, and independently of whether their present dips were acquired then or subsequently; provided only that the new rocks were forming on, and from the old. But whether or not this be the case, the following phenomena are interesting.

The mines known as the Dillsburg Group lie too close together to enable one to predicate anything with confidence from them alone as to the direction of the one or more belts of ore in which they are sunk, but if we connect together the three northeasternmost ore properties mentioned in General Map C C 1875. (Meyer's, Ellicker's and Kimmel's) with the group around Franklintown, the line is very nearly E. 25° N. *i. e.* that of the above mentioned strike of the Huronian measures. Moreover there does seem to be a certain conformability of the Dillsburg and other groups to this line. [N. B.—The strike of sandstone 60 ft. down in the Altland bank group is about E. 30° N.—nearly the same.]

It chances that the average dip of the South Mountain rocks remains pretty uniform from N. E. to S. W., so that if there were any foundation

Digitized by Google

for the supposition, we ought to be able to follow one or more belts of ore in a tolerably straight course from one formation into the other.

On the general map to illustrate the report of 1875, lines were drawn from the Franklintown ore diggings, E. 27° N. and W. 27° S. The first of these passes through the locality where ore has been prospected at Meyers', Ellicker's, and Kimmel's. The W. 27° S. line passes through the town of Whitestown (or Idaville), where was a once famous iron mine. All these three occurrences are clear of the mountain range. The first two are in the New Red, the last in the older (Huronian) crystalline schists or in the mixed marginal formation. Continuing this line still further W. 27° S. it cuts the very singular ore mine of G. Coles in the Catholic Valley (a small valley among the South Mountain ridges). This same line emerges in the Cumberland Valley where several new ore pits sunk by Col. Wiestling have proved the existence of ore.*

Drawing a parallel line of W. 27° S. from the Dillsburg group, we cross the Bender, McCormick and Williams limonite mines in the first high land of the mountains about 6.5 kilometers (or a little more than four miles) S. W. of Dillsburg. Near the Chambersburg turnpike this line crosses the "Furnace bank" opening, which can be seen from the turnpike on the brow of a steep hill just across (W. of) the Connococheaque.

If we move the parallel ruler from this line till it pass through Pine Grove, and draw another line, this latter will very nearly pass through Medler and Sayler's and the Thomas Iron Co.'s banks S. E. of Papertown, in one direction, and through the Hoosac Run Mine of the old Caledonia Furnace property in the other, emerging from the mountains near the mouth of Cold Spring Ravine at the ore opening of Mr. Good.

Thus it will be remarked that not only does the characteristic strike line of the old Huronian rocks enable us to pass from known ore localities in the older, to known localities in the newer formation ; but all the important mines of this particular region yet known in both formations can be connected together by two or three such lines.

* It is doubtful if the latter is more than a coincidence, as the portion of this line between Coles' ore mine and the Cumberland Valley probably crosses the line of a great fault and thrust : the most important dynamic element in the formation of these mountains.

Digitized by Google

American Condensed Peat: Experimental Tests to Determine its Value for Blast and Puddling Furnace Use, &c.

BY J. BLODGET BRITTON.

(*Read before the American Philosophical Society, April* 20, 1877.)

At the meeting of the fifth of January last I exhibited a small sample of condensed air-dried peat, prepared by the Dodge process, at works in operation near Syracuse, N. Y., under the direction of Jas. M. Hart and others, and stated that my purpose was to ascertain by analysis its general composition in order to find what value it possessed for blast and puddling furnace use and generating steam in boilers, and would communicate to the Society the results obtained. Since then I have received more of the same material charred, and some samples prepared by the Wright process, at works at Rome, N. Y., under the direction of the patentee, W. E. Wright; and also some samples of true brown coal or lignite, apparently a derivative of peat, found in considerable quantity in more or less disconnected deposits of from one to seven feet in thickness, principally in the region of the Ouachita River in Southern Arkansas. In order to embrace in the communication the results of the analyses of these last samples, there has been more delay than was anticipated. Portions of the samples are now presented for inspection and comparison, and also I respectfully submit the results of the analytical examinations so far made.

The lignite has a specific gravity of 1.29. It is lighter in color than the peats, and more uniform in structure, but by exposure to a drying atmosphere, however slowly the drying is effected, becomes quite friable, and at once breaks into pieces when roughly handled. It ignites most readily, and with a draft gives a long, bright flame and very little smoke, but would not answer the purposes of the blacksmith; it does not cake or form a coherent coke.

Results of analysis.

Water	23.62
Crude oleaginous matter	12.49
Other volatile matter more or less combustible	28.44
Ash	4.85
Fixed carbonaceous matter	30.60
Total	100.00

Included in the above:

Sulphur	.551
Sulphuric acid	.322
Phosphoric acid	.007

Digitized by Google

Composition of the Ash.

Ferric oxide	24.45
Silica	40.14
Alumina	26.61
Lime	6.31
Magnesia	.16
Sulphuric acid	.60
Phosphoric acid	.12
Alkali, undetected matter and loss	1.61
Total	100.00

The sample of peat marked "From Illinois" (about 1 lb.), came with the one from the Syracuse Works, and was prepared, it is supposed, by the Dodge process, specific gravity 1.32.

Results of Analysis.

Water	13.90
Volatile matter more or less combustible	48.70
Ash	15.26
Fixed carbonaceous matter	22.14
Total	100.00

Included in the above:

Sulphuric acid	.30
Phosphoric acid	practically none

Composition of the Ash.

Ferric oxide	9.50
Silica	43.00
Alumina	18.20
Lime	24.41
Magnesia	.18
Manganous oxide	.22
Sulphuric acid	1.90
Phosphoric acid	trace
Alkali, undetected matter and loss	2.59
Total	100.00

The sample of peat from the Syracuse Works (about 40 lbs.) was dug from an extensive bog nine miles north of the city, and prepared by grinding into pulp in a bath of water and then draining and air-drying. The cost of the material in quantity, cut and broken into pieces somewhat larger than a man's fist, and dried in condition like the sample exhibited, is stated to be not exceeding $1.25 per gross ton. It is not at all friable

Digitized by Google

but, on the contrary, is tough and strong, and will bear rougher handling than many of the bituminous coals. It ignites readily, and, like the lignite, burns with a long, bright flame and little smoke. The specific gravity of the pieces tested varied considerably from below 1 to 1.28; not more than one-half of them sunk in water.

Results of Analysis.

Water	21.68
Crude oleaginous and tarry matter	16.47
Other volatile matter more or less combustible	28.27
Ash	8.12
Fixed carbonaceous matter	25.46
Total	100.00

Included in the above:

Sulphuric acid	2.325
Phosphoric acid	.068

Composition of the Ash.

Ferric oxide	7.55
Silica	13.35
Alumina	6.54
Lime	44.31
Magnesia	1.26
Manganous oxide	trace
Sulphuric acid	21.60
Phosphoric acid	.74
Alkali, undetected matter and loss	4.65
Total	100.00

The sample of charred peat (about 8 lbs.) had an average specific gravity of 1.22. It was friable, and with ordinary handling broke into pieces of the size of a walnut and less. A portion of it was thoroughly dried, but afterward found to reabsorb moisture from the atmosphere readily; exposed to the air in a chamber of the laboratory, it regained 7.20 per cent. in 48 hours.

Results of Analysis.

Water	13.10
Volatile matter more or less combustible	22.69
Ash	15.27
Fixed carbonaceous matter	48.94
Total	100.00

These results show that the material had not been thoroughly coked, but merely charred. Tested in a good 12 inch wind assay furnace it

Digitized by Google

failed to produce heat sufficient for the reduction of an ore of iron to a button of metal; the quantity, though, was scarcely sufficient for a con clusive test. It burned with a roar, and gave flame enough to heat the pipe red-hct for some distance, which I never found anthracite to do in the same furnace.

The sample of peat from Rome, N. Y. (about 50 lbs.), was dug from a bog in Oneida county, where large bodies of it exist, and prepared by first grinding into pulp, then partially compressing and air-drying, and, lastly, more completely drying in a current of air artificially heated. The cost of preparing in quantity is estimated at under $1.50 per gross ton. The pieces, like those of Syracuse article, are of suitable size, tough and strong. The specific gravity varied mostly between 1 and 1.21; nearly all of the pieces tested sank in water.

Results of Analysis.

Water	14.39
Crude oleaginous and tarry matter	19.77
Other volatile matter more or less combustible	30.59
Ash	12.40
Fixed carbonaceous matter	22.85
Total	100.00

Included in the above:

Sulphuric acid	1.44
Phosphoric acid	.17

Composition of the Ash.

Ferric oxide	7.91
Silica	35.24
Alumina	14.83
Lime	25.21
Magnesia	.36
Manganous oxide	1.05
Sulphuric acid	11.32
Phosphoric acid	1.35
Alkali, undetected matter and loss	2.73
Total	100.00

A portion of this sample was tested in the assay furnace with about the same effect as that produced by the charred peat. Another portion was tested for liability to absorb moisture from the atmosphere, and found to regain 7.70 per cent. at a temperature between 65° and 73° F. in three days. What it would regain out of doors in a covered, latticed bin can be inferred.

From the facts stated it is clear that neither of the samples examined would be equal to wood charcoal for use in blast furnaces as they are now

Digitized by Google

constructed; if, unmixed with other fuel, they would answer for such use at all with profit. If they were coked and made into a compact coal, tough enough to withstand the pressure and abrasion of the ore and flux without unduly crushing—which, I believe, would be quite impracticable with the lignite—they might answer well; the large quantity of ash they contain would be the only objection. The ash, however, being rich in lime and also containing some potash and soda, would not prove very refractory. The sulphuric acid would not become reduced and give sulphur to the iron, but pass off mostly as sulphate in the slag, and the phosphorus present being small would have little effect. The peat from Illinois would afford 68.92 of ash with 100 parts of fixed carbon, that from Syracuse 31.50, and that from Rome 54.22. Wood charcoal usually affords less than 1 per cent. of ash; coke from bituminous coal, variable, but usually less than 12 per cent., and anthracite, also variable, but usually less than 8 per cent.

As a fuel for use in puddling furnaces these condensed peats would unquestionably answer, and best when well dried. They would burn freely without caking or forming any undue amount of clinker, require no excess of blast or draft, and afford combustible gas free from sulphur in greater volume than the ordinary bituminous coals. By mixing the gas with heated air at or near the bridge walls, an exceedingly high heat could be produced. For use in the Siemens regenerative furnace they would be especially well adapted, their contents of moisture being no disadvantage, but decidedly beneficial. Burning, as they could be made to, with a long, hot and almost smokeless flame, their value for the production of steam in stationary and other boilers would be great, and for the production of an illuminating gas of high candle power they would be no less valuable. I regard them as not at all liable to spontaneous combustion.

Much has been said of the value of peat for fuel purposes. The literature upon the subject is voluminous. My conclusions, however, are not drawn from anything hitherto published, but alone from the facts revealed by the analyses and tests made as stated. Peats differ more or less, and some very widely in the relative proportions of their constituents, and their fitness for use depends materially upon the manner in which they are prepared; hence, to determine the true value of any one, a chemical analysis and other tests should be resorted to.

Digitized by Google

Stated Meeting, April 6, 1877.

Present 19 members.

Vice-President, Mr. PRICE, in the Chair.

Letters accepting membership were received from E. H. Von Baumhauer, Harlem, March 7, 1877; from C. Wm. Siemens, 12 Queen Ann's Gate, Westminster, S. W., March 14, 1877; and from Mariano Barcena, dated Meteorological Central Observatory, Mexico, March 25, 1877.

Letters of acknowledgment were received from the Academy at St. Petersburg, February 26 (62, 74, 97); Royal Society of Sciences, Göttingen, February, 1877 (97); Royal Library, Leipzig, February 4 (97); S. de Phy. Geneva, December 1, 1876 (94, 95, XV, ii); Royal Danish Academy, Copenhagen, March 13 (97); Chicago Academy of Science, March 6 (Proc. 16, 17, 33, 35 to 39, Vol. III, Vol. V, wanting 44, Vol. VIII to XIV, 78, 94, 95, 96, 98).

Letters of envoy were received from Dr. A. Dreschler, Dresden, February 11; Royal Academy, Vienna, September 29, 1876; Royal Observatory, Greenwich, March 1877; Meteorological Office, London, March 1877; Howard College Observatory, April 3; United States Lighthouse Board, March 22; United States Naval Observatory, January 31; and the Department of the Interior, April 3, 1877.

Donations for the Library were received from the Nic. Observatory, St. Petersburg; Royal Danish Academy; Royal Academy, Vienna; M. Adolph Dreschler; the Society at Ulm; Neu Lausitz. Magazin, Görlitz; N. H. S. Bonn; Royal Society Göttingen; Flora Batava; S. de Phy. and M. H. de Saussure, Geneva; Royal Academy of Lincei, Rome; National Library and Faculty of Medicine, Madrid; Society of the Friends of Peace at Valentia; Central Geographical Commission of Lisbon; Portuguese Commissioners to the Centennial; Royal Astron. Society, Society of Arts, and Nature, London; Lit. and P. Society, Liverpool; Astronomical Observatory, Harvard College; Com.

Digitized by Google

Corr. Old South Church, Boston; B. N. H. S.; Silliman's Journal; American Chemist; Geological Survey of New Jersey; Academy Natural Science; Franklin Institute; College of Pharmacy, and E. D. Cope; United States Naval Observatory; Signal Service Office; Light House Board; Botanical Gazette, Hanover, Ind.; University of California, Berkeley; and the Brazilian Biographical Annual, Rio de Janeiro.

The death of Prof. J. S. Hart, aged 67, at his residence in Philadelphia, March 26, 1877, was announced by the Secretary.

Prof. Frazer exhibited and described the construction and use of a new compass devised by Major Brooks, for field work, to detect and measure local attraction more accurately than the ordinary dipping needle.

Prof. Frazer communicated a paper on Magnetic Declination.

The Secretary read a paper, entitled "On the relative ages of the Sun and certain of the Fixed Stars, by Prof. Daniel Kirkwood of Indiana University," which was discussed by the members present.

The Secretary presented, for Dr. Brinton, a paper, entitled "The Timucua Language, by Albert S. Gatschet."

The Secretary read a short communication from Mr. C. E. Hall, entitled "Contribution to the Palæontological Museum of the Second Geological Survey of Pennsylvania," describing the late discoveries of Eurypterus (hitherto characteristic of the Silurian Water Lime rocks) in the Subcarboniferous and Carboniferous of Northern and Western Pennsylvania, by Mr. Carll and Mr. Mansfield.

Dr. Le Conte read portions of a private letter and described the activity of the new Society of Sciences at Davenport, Iowa;—on motion the placing of that Society on the list of Correspondents was referred to the Publication Committee.

On motion the Secretaries were authorized to accept Mr. Sinclair's contract to make for $25 a piece, two plates to il-

Digitized by Google

lustrate Prof. Cope's paper on the brain of Coryphodon Elephantopus.

Mr. E. K. Price offered the following resolution which was seconded and passed:

Resolved, That since by the death of Messrs. Durand, Trego and Guillou, there are three vacancies in the Committee on the Michaux Legacy, that said vacancies be now filled by new appointments.

Mr. Joseph P. Townsend, Mr. Aubrey H. Smith, and Mr. W. M. Tilghman, nominated respectively by Mr. Price, Dr. Cresson and Mr. J. S. Price, were elected to fill the vacancies.

Mr. E. K. Price offered the following resolution, which was seconded and passed:

Resolved, That the Committee on the Michaux Legacy be authorized to consider and report to the Society, from time to time, what appropriations should be made of the residue of the income of that Legacy, so that the purposes of his will may be faithfully executed.

Dr. Barker having explained that Prof. Draper, elected member of this Society in 1844, had never received copies of the Proceedings, and there being no likelihood that the Society would incur at present the expense of reprinting the exhausted numbers of the series, it was moved and adopted that the Secretaries be authorized to make an exception specially in his case, and take one of the twenty reserved sets, from the beginning, and present it to Prof. Draper.

Pending nominations number 830 to 834, 835, and new nomination 836 were read.

And the meeting was adjourned.

Stated Meeting, April 20th, 1877.

Present, 15 members.

Vice-President, Mr. Fraley, in the Chair.

Letters of envoy were received from the Austrian Academy, Vienna, November 1, 1876.

Digitized by Google

Letters of acknowledgment were received from the Royal Society, Edinburgh, Dec. 1876 (XV, ii, 94, 95); and the McGill University, Montreal, April 5, 1876.

Donations for the Library were received from the Austrian Academy, many volumes of the Novara Expedition; the Royal Society, Melbourne; the Geographical Society and Revue Politique, Paris; Lord Lindsay (Editor of the Dunn Observatory Observations), and London Nature; the Royal Edinburgh Society; Essex Institute; White Mountain Alpine Club (Appalachia), Boston; Antiquarian Society, Worcester; American Chemist; A. N. Williamson, M. D., New York; Buffalo Society of Natural Sciences; A. Journal Medical Sciences; Medical News; Penn Monthly; Committee of National Centennial Celebration, Philadelphia; U. S. Department of the Interior; and the Botannical Gazette, Hanover, Indiana.

The death of a member, Dr. Alexander Braun, at Berlin, March 29, 1877, aged 71, was announced by a circular family letter.

Mr. Britton exhibited specimens of lignite and peat, and pressed fuel from peat manufactured in the State of New York, and read a paper explanatory of the process and value of the fuel, with analyses made in his own laboratory.

Several written communications handed to the Secretary for presentation to the American Philosophical Society, by the Rev. J. L. Gross, were read by title by the Secretary.

Professor Frazer read a communication of facts which he had observed in his survey of York and Adams Counties, Pennsylvania, and discussed the views of Prof. H. D. Rogers and others respecting the cause of the general north-west dip of the New Red and of the origin of the magnetic and specular iron ore beds of the New Red and of the Azoic rocks of the South Mountains, insisting specially upon one point, viz.: that parallel straight lines about N. 20 E. may be drawn through all the ore banks of any consequence, irrespective of their habitat in the two formations; a fact which seems to make the ores common to both by some law not yet

Digitized by Google

discovered. He presented for the examination of the members in support of this fact, one of the recently published maps of his district.

Pending nominations, Nos. 830 to 836 and new nominations Nos. 837 and 838 were read.

Pending nominations, Nos. 830 to 835 were spoken to and balloted for.

The Resolutions of Prof. Frazer to recommend the addition of metric units to English units in papers prepared by members for publication; and Dr. Roger's amendment to order the conversion of metric units when used into English units, postponed from March 16, 1876, were called up, debated at much length, and not agreed to.

The ballot boxes being scrutinized by the presiding officer, the following persons were declared duly elected members of this Society.

830. Prof. Henry Draper, M. D., of New York City.

831. Dr. J. T. Rothrock, Prof. Botany, University, Pa.

832. Mr. James Douglass of Phœnixville, Pa.

833. Prof. J. J. Stevenson, University of New York, and Assistant Geologist Second Geological Survey of Pennsylvania.

834. Dr. George R. Moorhouse, of Philadelphia.

835. Dr. T. B. Reed, of Philadelphia.

And the Society was adjourned.

Stated Meeting, May 4th, 1877.

Present 16 members.

Vice-President, Mr. Price, in the Chair.

Mr. H. Armitt Brown, a newly elected member was introduced to the presiding officer and took his seat.

Letters accepting membership were received from Prof. J. J. Stevenson, 314 West Thirtieth Street, New York, April

Digitized by Google

24, 1877; Dr. Thos. B. Reed, dated Philadelphia, April 24, 1877; Prof. Henry Draper, 271 Madison Avenue, New York, April 24; Dr. Geo. R. Moorhouse, 227 South Ninth Street, Philadelphia, April 25, 1877.

Letters of acknowledgment were received from the Imperial Russian Society (95,97); Imperial Central Meteorological Establishment (97); and the Astronomical Society at Leipzig (97).

A letter of envoy was received from the Meteorological Office in London.

Donations for the Library were received from the Berlin Horticultural Union and African Exploration Society; the Vienna Anthropological Society and Geological Establishment; the Brussels Academy, and Netherland Botanical Society; Annales des Mines; London Astronomical, Asiatic, Antiquarian and Zöological Societies; Meteorological Office, and Editors of Nature; Greenwich and Radcliff Observatories; and the Observatory at the Cape of Good Hope; Mr. James Young and Mr. R. Angus Smith of Edinburgh; the Essex Institute; Silliman's Journal; Franklin Institute; College of Pharmacy; Prof. Cope and Mr. J. Meehan; the University of Virginia; Wisconsin Academy of Sciences: and M. Barcena of Mexico.

The death of General Wm. A. Stokes, at Philadelphia, May 3, in the 63d year of his age, was announced by Mr. Price.

Prof. Cope exhibited and described a plaster cast of the Cranial Cavity of a fossil *Procamelus Occidentalis*, from near Sante Fé, New Mexico, comparing it with the brain of the llama.*

Prof. Cope communicated a catalogue of 43 species, (about 20 of them new) of living batrachia; entitled "Synopsis of the cold-blooded vertebrata procured by Prof. James Orton during his explorations of Peru in 1876-77." Prof. Orton has added greatly to the value of his catalogue by

*This and following communications will be published in the next volume (XVII) and No. (100) of the Proceedings.

Digitized by Google

giving the elevation above tide at which each species was noticed. Thus, a *Bufo* was seen ranging from the seaboard to a height of 14,500′, without material noticeable change of aspect.

Prof. Sadtler communicated a paper "On some new chlorine derivations from Toluole, by Dr. E. F. Smith of the University of Pennsylvania.

Mr. Lesley communicated and read a part of a Report by Mr. J. F. Carll, Assistant Geologist on the Second Survey of Pennsylvania in charge of the Oil District; describing the success and method of his efforts to regulate and harmonize the Railroad and Oil Well Levels above tide in North-western Pennsylvania.

Pending nominations 836, 837, 838, were read.

Dr. Rogers announced that the Committee on the Wooten Slack-Burner would be ready to report at the next meeting of the Society.

Mr. Fraley reported that he had paid into the Treasury $143.07, being interest due on the Michaux Legacy, April 1, 1877.

Mr. Price, Chairman of the Committee on the Michaux Legacy reported the action of the Committee at its meeting April, 25, 1877, as follows:

Report.

"At a meeting of the Committee on the Michaux Legacy, held April 25, 1877, present, F. Fraley, Aubrey H. Smith, Wm. M. Tilghman, Jos. B. Townsend, and Eli K. Price.

"On motion it was resolved to recommend an appropriation of two hundred dollars for the expenses of a course of Lectures contributing to the extension and progress of Silvyculture, to be delivered by Dr. T. F. Rothrock, of the University of Pennsylvania.

"*Resolved*, That the Chairman of this Committee be requested to confer with Dr. Rothrock, with the view to the preparation of a syllabus of such a course, and the time and plan for the delivery thereof, in case the above resolutions should meet the approbation of the Society.

"Dr. Rothrock afterwards met the Chairman and Mr. Fraley, and consents to lecture once a week in the Park, and to fill out the syllabus herewith reported."

[Signed.] ELI K. PRICE, CHAIRMAN.

Digitized by Google

The following resolution offered by Mr. Price with a blank for the sum to be appropriated, was debated at length, the blank filled, and passed unanimously:

Resolved, That an appropriation of four hundred and fifty dollars ($450) be made out of the income of the Michaux Legacy, to defray the expenses of a course of lectures in Horticultural Hall, Fairmount Park, on Silvyculture, to be delivered by Dr. Rothrock.

And the meeting was then adjourned.

Syllabus of Lectures on Silvyculture.

To Mr. Eli K. Price,

Chairman of the Committee on the Michaux Fund of the American Philosophical Society, and of the Committee on Trees and Nurseries of the Fairmount Park Commissioners.

Dear Sir:—I have the honor to submit the following as an outline of the proposed Lectures in the Park:

1. Sketch of André Francois Michaux. Outline of the journeys made by him and by his father in North America. The primary object being the introduction into France of American plants and especially American trees. This was an early recognition there of the actual necessity of Arboriculture in its relation to the future. Provision made by William Penn, July 11, 1681, that "in clearing the ground care be taken to leave one acre of trees for every five acres cleared, especially to preserve Oak and Mulberry Trees for silk and shipping." Tree destroying tendency of the American people has been matured into an instinct.

2. Recognized need in Europe of replacing forests destroyed and of protecting those that remain has developed a matured system of Forestry. Give an outline of this system.

3. Immediate necessity for some such system in the United States, growing out of ruthless destruction of our extreme forests. Immediate action required to prevent serious injury to the future interests of commerce and of the arts in our country by a continuance of this unrestrained destruction, without any corresponding measures being taken to replace the first growth.

4. Influence of extensive forests (and vegetation generally) on face of country: 1st, from an æsthetic point as illustrated by Humboldt's Views of Nature; 2d, by either increasing or conserving rain fall; 3d, by preventing rapid evaporation on one hand and destructive freshets on the other; 4th, by moderating climate, *i. e.*, warding off destructive winds,

Digitized by Google

and by supplying aqueous vapor to prevent a too free radiation of the earth's heat back into space at night.

5 and 6. Distribution of Forests in North America; their present and prospective relation to the wants of man.

7 and 8. Treeless regions of North America. How they limit areas of cultivation by increasing areas of evaporation. How can the area of these treeless regions be decreased, and at the same time made routes for conducting water to areas of cultivation?

9. Necessity for such measures: Result—a true and legitimate economy in government to aid in them.

10 and 11. Economic Arboriculture, as related to homes, home health and the useful arts.

12. Exotic trees to be introduced, and the propriety of government supporting extensive experimental and propagating arboretums.

13 and 14. Plants of cultivation and the changes produced by cultivation in them.

15. How plants are constructed, *i. e.*, popular sketch of their anatomy.

16. How plants are perpetuated and how they "behave."

17. Means taken to distribute them over the globe, and some striking examples furnished.

18. Succession of vegetable life on the globe.

19. Chemistry of vegetation.

20. Evidences of design in the vegetable kingdom.

In the above I have endeavored to keep within the limitation implied in the will of André Francois Michaux, *i. e.*, that his legacy was intended to contribute to the extension and progress of Agriculture and more especially in Silvyculture in the United States.

Very respectfully, J. T. ROTHROCK.

May 2, 1877.

Digitized by Google

Digitized by Google

INDEX TO VOLUME XVI.

Members Elected.

*Members who have accepted by letter. †Members who have taken their seats.

Members Resigned.

Members Deceased.

*Note.—Dr. J. B. Biddle, appointed to prepare obituary notice of Dr. Joseph Carson, ... 381, 385
Mr. Frederick Fraley, " " " " " Prof. J. C. Cresson, ... 196
Mr. Henry M. Philips, " " " " " Mr. Theodore Cuyler, ... 230

Digitized by Google

Obituary Notice Read.

Change of Residence.

Photographs of Members Received.

Special Correspondence.

Business of the Society.

Digitized by Google

Written Communications in the Proceedings.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Miscellaneous.

Digitized by Google

Digitized by Google

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA

FOR

PROMOTING USEFUL KNOWLEDGE

Vol. XVI.

JANUARY 1876 TO MAY 1877.

PHILADELPHIA:
PRINTED FOR THE SOCIETY
BY M'CALLA & STAVELY.
1877.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google